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Preliminary Investigation of Light-Duty Diesel Catalysts

Southwest Research Inst.
San Antonio, TX

Prepared for

Environmental Protection Agency
Ann Arbor, MI

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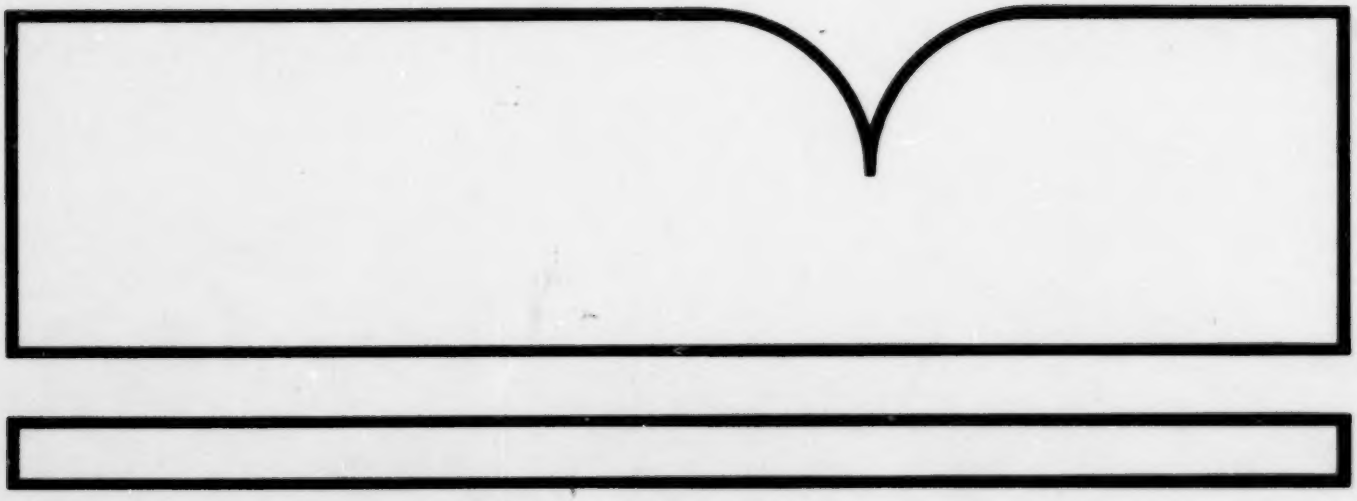

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Emission Control Technology Division
2565 Plymouth Road
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Air

EPA

PRELIMINARY INVESTIGATION OF LIGHT-DUTY DIESEL CATALYSTS

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This report describes the laboratory testing of prototype Diesel catalytic converters on a production light-duty Diesel vehicle. Two manufacturers submitted catalysts which were retrofitted on the vehicle's exhaust system individually. Regulated and several unregulated emission rates were determined during the Federal Test Procedure (FTP) and the Highway Fuel Economy Test (HFET) for each system. Particulate rates and particulate collection for Ames bioassay was also determined. In addition to fresh Diesel catalysts, an aged Diesel catalyst was also evaluated. The emission rates of hydrocarbons (HC), carbon monoxide (CO), oxides of nitrogen (NOx), individual hydrocarbons, aldehydes, sulfates, and particulates are reported in grams per kilometer.

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PRELIMINARY INVESTIGATION OF LIGHT-DUTY DIESEL CATALYSTS

by

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Contract No. 68-03-2220
Modification 8

EPA Project Officer: Robert J. Garbe

Prepared for

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Emission Control Technology Division
Ann Arbor, Michigan 48105

January 1980

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Publication No. EPA-460/3-80-002

FOREWORD

This project was conducted for the U.S. Environmental Protection Agency by the Department of Emissions Research of Southwest Research Institute. The laboratory testing phase of the project began in May 1979 and was completed in July 1979. This project was conducted under EPA Contract No. 68-03-2220, Modification 8 and was identified within Southwest Research Institute as Project 11-4311-003. The EPA Task Officer was Mr. Robert J. Garbe of the Emission Control Technology Division, Environmental Protection Agency, 2565 Plymouth Road, Ann Arbor, Michigan. The Southwest Research Institute Project Manager was Mr. Karl J. Springer. The project leader was Bruce B. Bykowski.

ABSTRACT

This report describes the laboratory testing of prototype Diesel catalytic converters on a production light-duty Diesel vehicle. Two manufacturers submitted catalysts which were retrofitted on the vehicle's exhaust system individually. Regulated and several unregulated emission rates were determined during the Federal Test Procedure (FTP) and the Highway Fuel Economy Test (HFET) for each system. Particulate rates and particulate collection for Ames bioassay was also determined. In addition to fresh Diesel catalysts, an aged Diesel catalyst was also evaluated. The emission rates of hydrocarbons (HC), carbon monoxide (CO), oxides of nitrogen (NO_x), individual hydrocarbons, aldehydes, sulfates, and particulates are reported in grams per kilometer.

SUMMARY

A 1979 Oldsmobile Diesel vehicle was used to evaluate emissions from prototype Diesel catalytic converters supplied by two manufacturers. The vehicle's exhaust system was modified twice in order to accommodate each of the manufacturer's systems. The vehicle was tested with and without a converter over the Federal Test Procedure (FTP) and the Highway Fuel Economy Test (HFET). During each driving cycle, a series of regulated and unregulated emission tests were performed.

Tests of essentially new converters indicated catalytic activity by reducing CO on the average of approximately 85 percent and HC by approximately 55 percent during the FTP. Activity for both catalysts was even greater during the HFET with approximately 90 percent reduction of CO and 70 percent reduction of HC indicated. The particulate rates, for the most part, increased slightly during both cycles relative to the standard baselines. The sulfate rates increased substantially during both driving cycles although there was one exception to this finding. One catalyst exhibited good activity but no appreciable change in particulate and sulfate during the FTP. The NO_x levels increased slightly during both cycles for both catalytic converters. The individual hydrocarbons (methane, ethane, propane, ethylene, acetylene, propylene, benzene, and toluene along with the various measured aldehydes) were generally reduced. All the converters evaluated did not affect fuel economy.

An additional converter was also tested. It was identical to one of the new, fresh converters, but had been subjected to 31000 km road operation. The activity of this aged catalyst was somewhat reduced. Instead of the 80 and 50 percent reductions when new, the CO and HC reductions were 40 and 30 percent, respectively, during the FTP. The results during the HFET driving cycle indicated 60 percent reduction of CO and 55 percent of HC. The particulate rate increased slightly over its fresh counterpart.

The test plan also included particulate collection during the FTP for Ames bioassay on each catalyst and baseline test. A single 20 x 25 cm (8 x 10 inch) filter was used. The Ames results indicated essentially no difference in sample activity as measured by revertant colonies per mass of extracted organic matter for the catalyst samples, when compared to the non-catalyst samples. Converter inlet oxygen, temperature and exhaust back pressures were measured and are presented. The back pressure increased approximately 10 percent with one converter system and approximately 25 percent with the other. The average maximum inlet converter temperature was 215°C and the average minimum was 114°C during testing. It is inter-

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EPA-460/3-80-002

entitled

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The following correction is applicable to the above cited report which was issued under Project No. 11-4311-003, dated January 1980

Page 2

Sub paragraph b., line 3 now reads as follows:

was subjected to 31,000 km of road aging on a similar vehicle before de-

This line should be changed to read:

was subjected to 81,000 km of road aging on a similar vehicle before de-

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esting to note that the converters exhibited good catalytic activity at relatively low temperatures. As expected, the application of catalytic converters had little or no effect on fuel economy. No attempt was made to measure or investigate possible storage and purge of exhaust particulates.

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I. INTRODUCTION

On September 5, 1978, Modification 8 to Contract 68-03-2220 was authorized by the EPA Contracting Officer, Mr. Albert W. Ahlquist. The title of Modification 8 was "Light-Duty Diesel Vehicle Emission Testing." This modification was intended to investigate the feasibility of oxidation catalysts for emission control of Diesel-powered cars.

A. Objective

The objective of this project was to evaluate oxidation type catalytic converters with a Diesel car. In addition to regulated emissions, a variety of unregulated gaseous and particulate emissions were determined on a 1979 Oldsmobile vehicle equipped with a 5.7 liter Diesel engine. This vehicle was operated with and without the prototype Diesel catalytic converters.

B. Approach

The experimental approach was to modify the vehicle's exhaust system to accommodate the converters in the most optimum location. The vehicle was then tested without the catalytic converter to establish a baseline, and then with the converter system.

C. Scope

A total of three catalytic converters were evaluated, two fresh and one aged. Two catalyst manufacturers supplied the converters at the EPA Project Officer's request. A total of twenty-five gaseous and particulate tests were performed on the vehicle. Eight tests established baselines for the three converters and each unit was tested twice over two cycles. Each converter system was subjected to replicate tests to verify and increase confidence in the results.

II. PREPARATION AND PROCEDURES

This section describes the preparations, vehicle and equipment, fuel, catalysts, test procedures, and test plan employed.

A. Description of Vehicle and Components

The selection of the vehicle and catalytic converters were made by the EPA Project Officer. The Project Officer made the arrangements with the catalyst suppliers to provide the converters required for this research effort. The arrangements for the vehicle were made by SwRI.

1. Vehicle

A 1979 Oldsmobile Delta 88 with a 5.7 liter V-8 Diesel engine was selected as the vehicle to be used. The vehicle was leased from a local automobile leasing firm. The description of this vehicle is listed in Table 1.

2. Catalytic Converters

Two catalyst suppliers provided prototype Diesel oxidation catalysts for this investigation. The converters were located and installed in accordance with the wishes of both the supplier and EPA.

a. Engelhard

The two Engelhard converters employed were fresh monolithic oxidation catalysts identified as PTX-516. The exhaust system of the car was modified from its factory configuration in order to accommodate a catalyst in each bank of the exhaust system. This involved rerouting the crossover Y-pipe assembly from near the right exhaust manifold to near the muffler inlet.

b. UOP, Inc.

There were two UOP monolithic catalysts identified as UOP-99 and UOP-103. Both were identical with the exception that UOP-99 was subjected to 31,000 km of road aging on a similar vehicle before delivery to SwRI. For the UOP catalytic muffler, crossover Y-pipe assembly was returned to the factory configuration. A single UOP converter was installed close to the Y-pipe.

TABLE 1. ENGINE/VEHICLE PARAMETERS

Manufacturer:	Oldsmobile
Model:	1979 Delta 88
Engine:	5.7 liter V8 Diesel engine
Serial No:	3N37N9X14905
Inertia wt, kg (lb):	1814 kg (4000 lbs)
Power, kW (hp) @ rpm:	88.3 (120) @ 3600 rpm
Road Load Power, kW (hp) @ km/h(mph):	8.97 (12.2) @ 31 (50)
Compression Ratio:	22.5 : 1
Injection System:	Roosa Master
Combustion Chamber:	Pre-Chamber
Fuel:	Type 2-D Emissions
EPA Fuel Economy:	21 mph (city)
Transmission:	auto 3 speed
Tires:	GR-78-15 (steel belted radials)
Body Style:	2-door sedan

B. Description of Fuel

These tests were performed using a fuel that meets the Diesel fuel specifications listed in the Federal Register.[1]* This is the same fuel specification as that listed in the 1981 regulations.[2] Table 2 lists the results of the fuel analyses performed on the fuel used throughout this study.

C. Test Procedures

Test of all three catalytic converters as well as baseline gaseous emission tests followed published Federal Test Procedures.[1,2] The particulate emission rates were determined using the procedures published as Proposed Rules in the Federal Register.[2]

Several unregulated emissions were also determined using procedures documented in a recent EPA report prepared by SwRI.[3] Large particulate samples were also collected on 20 x 25 cm filters using a procedure described in Reference 4.

After completion of the regular 3-bag Federal Test Procedure[1,2], additional evaluations were performed using the Highway Fuel Economy Test Procedure.[5]

1. Federal Test Procedure (FTP)

All emission tests were performed on the vehicle according to the procedures set forth in the Federal Register.[1,2] The vehicle inertia weight was set to 1814 kg (4000 lbs) and road load power at 31 km per hour (50 mph) of 8.97 kw (12.2 hp). These settings were given by the EPA Project Officer as those used during EPA certification. The gaseous emissions of hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NO_x) were collected and analyzed using the procedures and equipment described in the regulations. The method of hydrocarbon analysis followed an updated version of what is proposed for 1981 in the Federal Register.[2] This system is presently used by the EPA and is anticipated to become a part of the 1981 FTP. Figure 1 shows the configuration of the heated hydrocarbon analysis system and Table 3 describes the components.

The tests were performed on a Clayton chassis dynamometer. A Constant Volume Sampler (CVS) with a nominal capacity of 0.28 cubic meters per second (600 CFM) was used in conjunction with a 45.7 cm (18 in.) dilution tunnel.

2. Highway Fuel Economy Test Procedure (HFET)

All emission tests were performed on the vehicle according to the procedures set forth in the Federal Register.[5] The equipment used was identical to that previously described. The HFET was run after a 10-minute soak period following the FTP.

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*Superscript numbers in parentheses refer to the List of References at the end of this report.

TABLE 2. TEST FUEL PROPERTIES

Fuel Code	EM-321-F
Fuel Type	2D Emissions (Howell)
Properties	
Density, g/ml	0.8403
Gravity, °API	36.9
Cetane, (D976)	49.07
Viscosity, CS (D445)	2.40
Flash point, °C	68
Sulfur, wt. % (D1266)	0.29
FIA: aromatics, %	30.5
olefins, %	1.1
saturates, %	68.4
Distillation (D86)	
IBP, %	194
10% point, °C	209
20% point, °C	220
30% point, °C	231
40% point, °C	237
50% point, °C	253
60% point, °C	265
70% point, °C	276
80% point, °C	288
90% point, °C	306
95% point, °C	324
EP point, °C	349
recovery, %	99.0
residue, %	1.0
loss, %	0.0
Carbon, wt. %	85.76
Hydrogen, wt. %	12.80
Nitrogen, wt. %	0.53
Gum (D381), mg/100 m.	10.6 (unwashed)
	9.2 (washed)

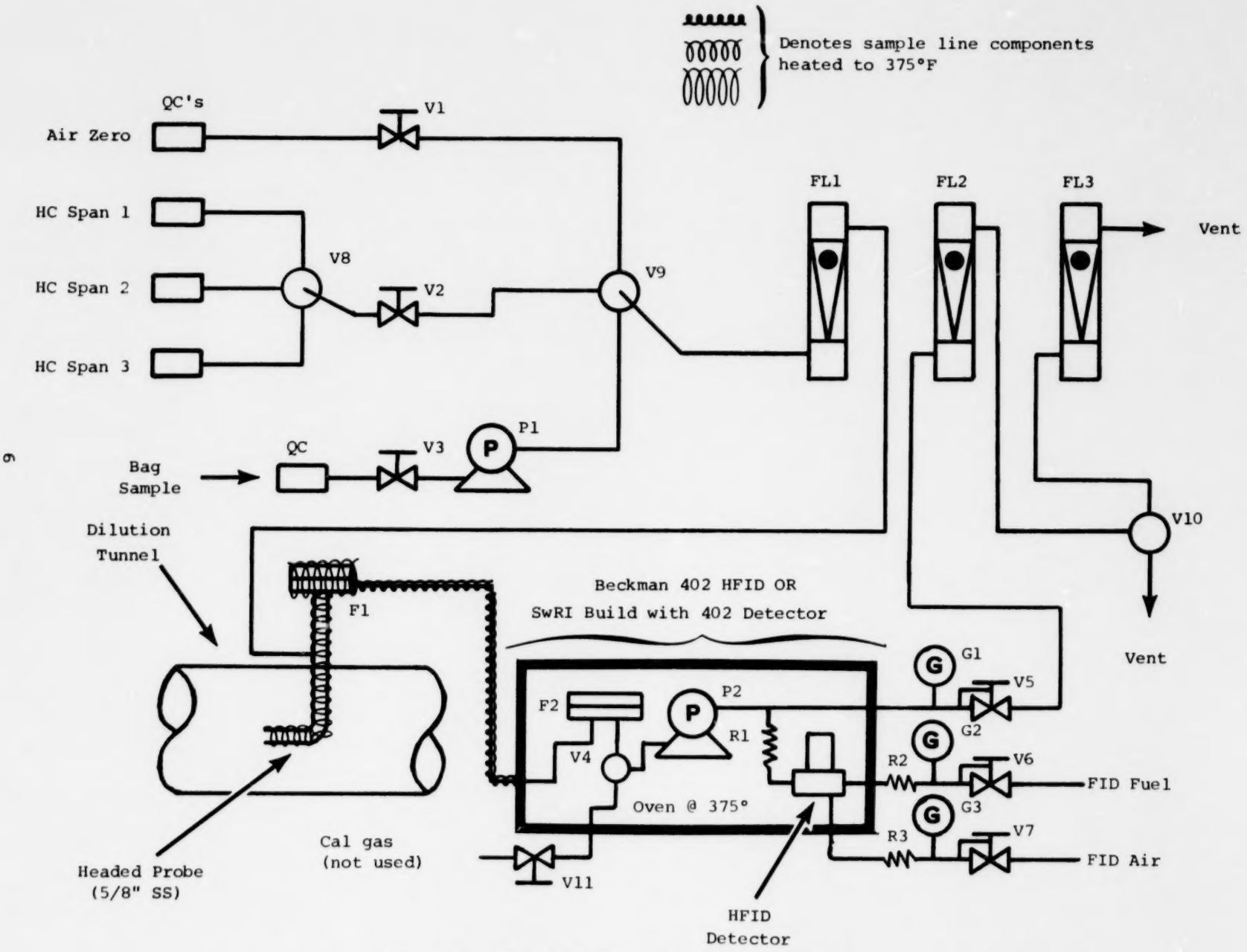


Figure 1. Heated hydrocarbon analyzer system

TABLE 3. HEATED HYDROCARBON ANALYZER OVERFLOW CALIBRATION AND SAMPLE FLOW SCHEMATIC COMPONENT DESCRIPTION

Component	Designation	Description of Function
Valve	V1	regulating valve for zero air
Valve	V2	regulating valve for HC span gas
Valve	V3	regulating valve for bag sample
Valve	V4	span/zero selector valve in HFID (not used)
Valve	V5	sample backpressure regulator
Valve	V6	FID fuel pressure regulator
Valve	V7	FID air pressure regulator
Valve	V8	HC span selector valve
Valve	V9	HC span/zero/bag sample selector valve
Valve	V10	leak check flow diverter valve
Restrictor	R1	sample capillary
Restrictor	R2	FID fuel restrictor
Restrictor	R3	FID air restrictor
Gage	G1	sample backpressure gage
Gage	G2	FID fuel pressure gage
Gage	G3	FID air pressure gage
Filter	F1	heated 7.0 cm filter (probe)
Filter	F2	heated 7.0 cm filter (oven)
Pump	P1	bag sample pump
Pump	P2	FID heated sample pump
Flowmeter	FL1	overflow flowmeter
Flowmeter	FL2	FID bypass flowmeter
Flowmeter	FL3	leak check flowmeter

3. Particulate

Particulate sampling followed the Proposed Rules in the Federal Register.[2] A multiprobe system was placed in the tunnel and will be described in detail further in this report. One of the probes was used for particulate sampling per the Proposed Rules[2] during both the FTP and HFET.

4. Sulfate

The exhaust sulfates were collected on 47 mm Fluoropore membrane filters with a 0.5 μm pore size. Fluoropore filters are made of PTFE (polytetraflurorethylene) and are a product of the Millipore Corporation. The sampling system incorporated the same configuration and equipment as the particulate collection. An additional probe was assigned for sulfate collection. The filters were extracted and analyzed using the barium chloranilate method.[3]

5. Aldehydes

The aldehydes were measured using the 2,4 dinitrophenylhydrazine (DNPH) method.[3] The method consists of withdrawing a continuous sample of dilute exhaust and bubbling the sample through glass impingers containing DNPH in hydrochloric acid. This formed the aldehydes' phenylhydrazone derivatives which were eventually injected into a gas chromatograph using a flame ionization detector for separation and identification.

6. Individual Hydrocarbons

The term individual hydrocarbons is used to define the collection and analysis of the following compounds: methane, ethane, ethylene, acetylene, propane, propylene, benzene, and toluene. The individual hydrocarbon (IHC) procedure[3] consists of collecting dilute samples in Tedlar (DuPont Co.) bags and injecting samples from the bags into a four-column gas chromatograph for separation and identification.

7. Ames Testing

In order to collect sufficient particulate matter to perform an Ames bioassay determination, larger Pallflex filters were used with a high volume sample pump and large probe. Pallflex filters consist of a glass fiber medium with a Teflon (DuPont Co.) binder and are a product of the Pall Corporation. The large probe was also a part of the multiprobe system installed in the dilution tunnel. The method used is described in Reference 4. There were a few changes in that Pallflex filters were substituted for the originally used glass fiber filters. The flow rate of the sample was 0.425 standard cubic meters per minute (15 SCFM) in order to collect an optimum amount of particulate and yet maintain a satisfactory filter face velocity.

8. Mileage Accumulation

The vehicle and related systems used a modified MVMA driving cycle[6] to accumulate mileage. The course is shown in Figure 2. This course was used for preconditioning the vehicle, converter and exhaust system prior to test.

9. Supplemental Parameters

Converter inlet oxygen concentrations and temperatures were monitored with continuous analyzers. Several taps were installed on the converters to withdraw raw exhaust samples for oxygen analysis by polarography. Type K thermocouples were located in some of the taps to measure the temperatures. Exhaust back pressures were measured at a 31 km per hours cruise condition using a mercury manometer.

D. Test Plan

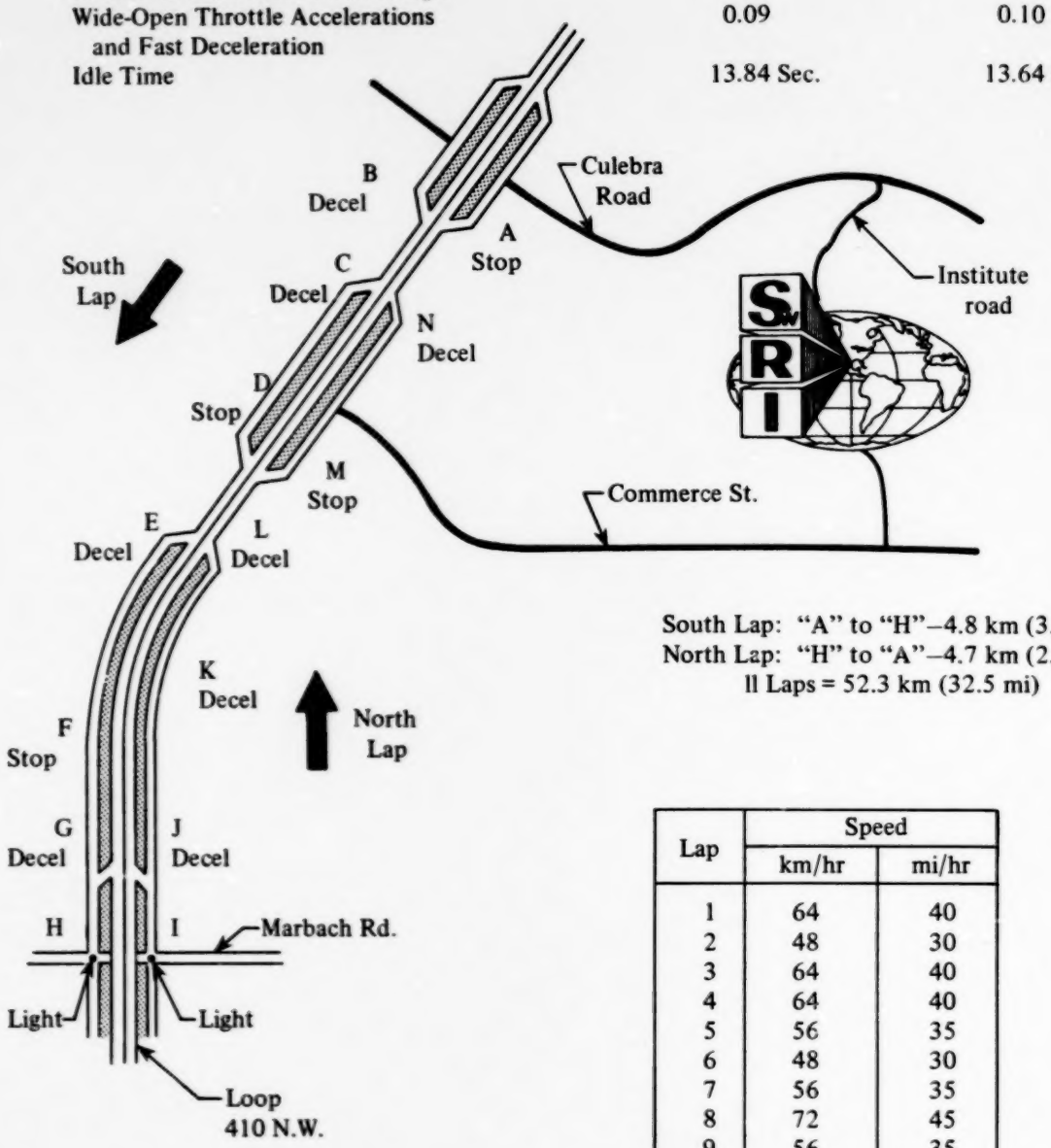
The experimental test plan, test sequence and test schedule are listed on Tables 4 and 5.

E. Installation Photographs

Figure 3 is a series of photographs showing the installation of and the various components used during this investigation. Figure 3A shows the catalytic converters supplied by two manufacturers. Figure 3B is a view of the multiposition sampling probe installed in the dilution tunnel. The probe extending out from the tunnel to the lower left hand corner of the picture is the probe used for particulate collection. This probe, as can be seen in the photograph, is split into two directions which is controlled by a single valve. This valve separates filter collection between the first 505 seconds and the last 866 seconds of the LA-4 cycle. The large 20 x 25 cm filters are placed in the rectangular holder near the top center portion of the picture.

Figure 3C and 3D show the location of each converter in the exhaust system of the vehicle. It should be noted that the converters are positioned as close to the exhaust manifold as possible. Figure 3E is a view of the instrumentation used during the operation of the vehicle on the dynamometer. Pictured in the center of the photograph is the strip chart recorder used to record continuous temperature, oxygen and hydrocarbon traces. On top of the recorder is two oxygen analyzers and to the left is the heated hydrocarbon analyzer. Figure 3F shows the vehicle on the dynamometer during test.

Driving Mode	Events Per Mile, 55 mph Top Speed	
	SwRI Course	AC No. 37
Stops	1.02	1.01
Normal Accelerations from Stop	0.92	0.91
Normal Accelerations from 20 mph	1.11	1.11
Wide-Open Throttle Accelerations and Fast Deceleration	0.09	0.10
Idle Time	13.84 Sec.	13.64 Sec.



South Lap: "A" to "H"–4.8 km (3.0 mi)
North Lap: "H" to "A"–4.7 km (2.9 mi)
ll Laps = 52.3 km (32.5 mi)

Lap	Speed	
	km/hr	mi/hr
1	64	40
2	48	30
3	64	40
4	64	40
5	56	35
6	48	30
7	56	35
8	72	45
9	56	35
10	89	55
11	89	55

Figure 2. Modified MVMA Driving Cycle

TABLE 4. EXPERIMENTAL TEST PLAN

Step	Item
1	Modify the as-received vehicle exhaust system to accommodate one Engelhard converter downstream of each exhaust manifold. This involves relocating the cross-over Y-pipe further downstream. The converters were to be as close to the exhaust manifold as possible. Use flanges on the converters and exhaust system for easy removal and installation.
2	Insulate the exhaust pipes from each exhaust manifold outlet flange to each converter inlet flange.
3	Install pressure, temperature and sample taps on both the inlet and outlet pipe section of each converter.
4	Construct straight exhaust pipes with the same dimensions as the converters, again using flanges. Install pressure, temperature and sample taps on the straight pipes.
5	Install straight pipes and fuel vehicle.
6	Accumulate 310 km using modified MVMA cycle.
7	Perform pre-test facility and instrumentation calibration. Prepare for filter and chemical analyses.
8	Perform 3-bag Federal Test Procedure gaseous emissions test with the following additions: a. Analyze HC by heated FID using the probe overflow method. b. Collect particulate samples on 47 mm filters. c. Collect concurrently two sulfate samples. d. Prepare to analyze each bag for individual hydrocarbons. e. Generate a continuous trace of inlet oxygen concentration. f. Generate a continuous inlet temperature trace. g. Collect a sample for aldehyde analysis. h. Collect a 20 x 25 cm Pallflex filter during cold transient and cold stabilize portion of the test.
9	After a 10 minute soak, perform the Highway Fuel Economy Test incorporating the following additions of Step 8: a, b, c, d, e, and f.
10	If a 20 x 25 cm filter was collected in Step 8, then two additional 20 x 25 cm filters are to be taken as follows: a. After the HFET, allow a 10 minute soak. b. Run an additional LA-4 cycle (1371 secs) and collect a second 20 x 25 cm filter. c. Allow an additional 10 minute soak. d. Run another LA-4 cycle and collect a third 20 x 25 cm filter.

TABLE 4 (Cont'd). EXPERIMENTAL TEST PLAN

Step	Item
11	Repeat Step 7.
12	Repeat Step 8a through 8g.
13	Repeat Step 9.
14	Install the Engelhard converters.
15	Repeat Steps 6 through 10.
16	Repeat Steps 6 and 7.
17	Repeat Steps 8a through 8g.
18	Repeat Step 9.
19	Reconstruct the exhaust system to accommodate a single UOP converter for the entire exhaust stream. Relocate the cross-over Y-pipe to the original location. The converter is to be as close to the Y-pipe as possible. Use flanges on the converter and exhaust system. Prepare UOP converters S/N 99 and S/N 103.
20	Repeat Steps 2 through 5.
21	Repeat Steps 7 through 10.
22	Install UOP converter S/N 103.
23	Repeat Steps 6 through 10.
24	Repeat Step 7.
25	Repeat Steps 8a through 8g.
26	Repeat Step 9.
27	Install the straight pipe.
28	Repeat Step 7.
29	Repeat Steps 8a through 8g.
30	Repeat Step 9.
31	Install UOP converter S/N 99.
32	Accumulate 62 km using modified MVMA cycle.

TABLE 4 (Cont'd). EXPERIMENTAL TEST PLAN

Step	Item
33	Repeat Steps 7 through 10.
34	Repeat Step 7.
35	Repeat Steps 8a through 8g.
36	Repeat Step 9.
37	Remove converter and reconstruct the exhaust system to original configuration.

TABLE 5. TEST SCHEDULE AND SEQUENCE

Test No.	Catalyst	Test Description	Analyses
-	None	310 km MVMA	-
1-1	None	FTP	1,2,3,4,5,6,7,8,9
2-1		HFET	1,2,4,5,7,8,9
		LA-4, LA-4	3,3
3-1	None	FTP	1,2,4,5,6,7,8,9
4-1		HFET	1,2,4,5,7,8,9
-	PTX-516	310 km MVMA	-
5-1	PTX-516	FTP	1,2,3,4,5,6,7,8,9
6-1		HFET	1,2,4,5,7,8,9
		LA-4, LA-4	3,3
-	PTX-516	310 km MVMA	-
7-1	PTX-516	FTP	1,2,4,5,6,7,8,9
8-1		HFET	1,2,4,5,7,8,9
9-1	None	FTP	1,2,3,4,5,6,7,8,9
		HFET	1,2,4,5,7,8,9
		LA-4, LA-4	1,3,3
-	UOP-103	310 km MVMA	-
10-1	UOP-103	FTP	1,2,3,4,5,6,7,8,9
		HFET	1,2,4,5,7,8,9
		LA-4, LA-4	3,3
11-1	UOP-103	FTP	1,2,4,5,6,7,8,9
		HFET	1,2,4,5,7,8,9
12-1	None	FTP	1,2,4,5,6,7,8,9
		HFET	1,2,4,5,7,8,9
-	UOP-99	62-km MVMA	-
13-1	UOP-99	FTP	1,2,3,4,5,6,7,8,9
		HFET	1,2,3,4,5,7,8,9
		LA-4, LA-4	3,3
14-1	UOP-99	FTP	1,2,4,5,6,7,8,9
		HFET	1,2,4,5,7,8,9

Number	Type of Analysis
1	CVS bags for CO, CO_2, NO_x
2	Continious HC - Hot
3	20x25 cm Pallflex (gravimetric)
4	47 mm Pallflex (gravimetric)
5	Individual hydrocarbons
6	DNPH (aldehydes)
7	Continious oxygen trace
8	Continious temperature trace
9	Sulfate

Typical Full Test Sequence

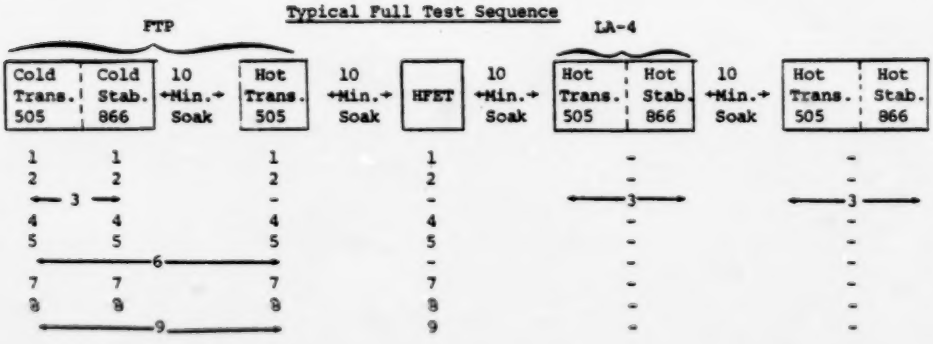


Figure 3A. UOP Converter (left), Engelhard (right)

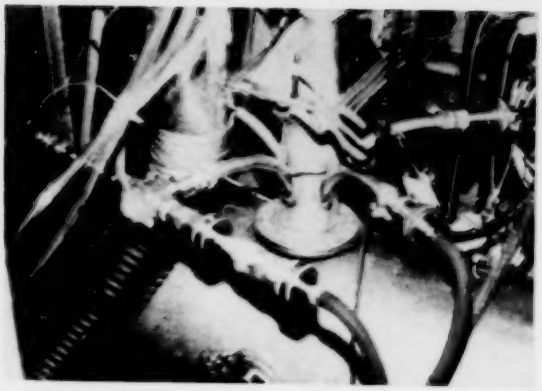


Figure 3B. Multiprobe installed into Tunnel

Figure 3C. Location of Engelhard Converters

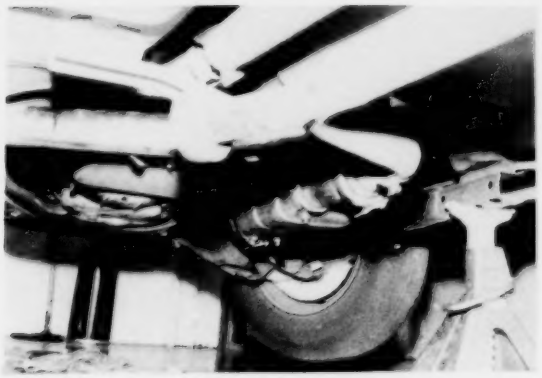


Figure 3D. Location of UOP Converters

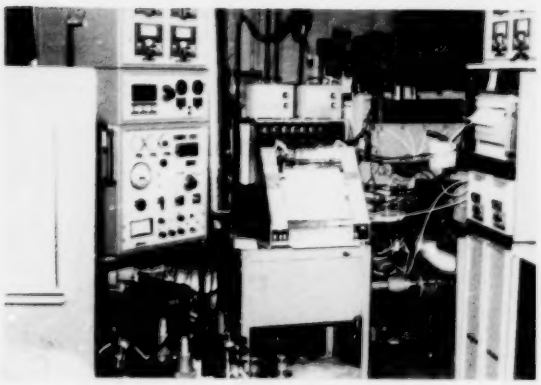


Figure 3E. Exhaust Instrumentation

Figure 3F. View of Vehicle on Dynamometer

Figure 3. Diesel catalyst testing installation

III. RESULTS

Although both catalyst systems were tested on the same vehicle using the same facilities and analyses, the results will be divided into two sections because of the different quantity of catalyst used in each system.

A. Engelhard Catalyst Results

FTP and HFET regulated and several unregulated emission results were obtained along with various related data.

1. FTP Results

All the emission results obtained during the FTP are summarized in Table 6. The catalysts exhibited significant activity by reducing CO by approximately 90 percent and HC by approximately 60 percent. There seemed to have been a slight increase in NO_x emissions. The tests were fairly repeatable and the additional 310 km of aging that the vehicle and catalysts were subjected to between Tests 6 and 7 did not apparently effect the catalysts' performance. It is important to note that the application of the dual Engelhard catalytic converters did not increase or decrease fuel economy.

The data summarized in Table 6 are from computer printout sheets included as Appendix A-1 to A-6 of this report. Tables A-1 through A-4 are the baseline and Engelhard FTP and HFET results. These printouts illustrate the cold-start and hot-start emissions performance of the catalytic converters and are provided for additional review and analysis. Please note on Tables A-2 and A-3 (second baseline and first Engelhard converter test) that corrected composite FTP values are listed. The corrected values were necessary to include the sample volume used in the 20 x 25 cm particulate filter. These tests were run in addition to the standard FTP and in effect increased the composite HC, CO and NO_x and decreased fuel economy. The amount of exhaust flow not accounted for by the CVS under the standard 1981 FTP was approximately 3 percent.

The aldehyde, individual hydrocarbon, and sulfate results also support the extent of catalyst activity. The reduction of the total amount of aldehydes was approximately 55 percent. Formaldehyde represents over half the aldehydes measured but its reduction was no greater than the others. Most of the individual hydrocarbons were reduced with the exception of methane and ethane which apparently have remained constant. The sulfate emissions increased approximately five times the baseline emission rate.

TABLE 6. FTP, HFET AND PARTICULATE EMISSIONS FROM 1979 OLDSMOBILE DIESEL DELTA 88 WITH AND WITHOUT A CATALYST

Test No.	Cycle	Catalyst	Date	Emissions Rates, g/km HC	CO	NO_x	CO_2	Consumption ℓ/100 km	Sulfate mg/km	Particulate Emission g/km
1	FTP	None	5-31-79	0.26	1.23	0.93	328.98	10.75	12.888	0.782
3	FTP	None	6-01-79	0.17	1.25	0.99	330.58	10.79	7.370	0.770
5	FTP	PTX-516	6-06-79	0.09	0.12	1.07	334.69	10.87	52.608	0.811
7	FTP	PTX-516	6-13-79	0.09	0.14	1.14	333.14	10.82	68.105	0.805
2	HFET	None	5-31-79	0.11	0.71	0.67	228.5	8.55	5.705	0.429
4	HFET	None	6-01-79	0.09	0.71	0.87	230.7	8.63	6.208	0.441
6	HFET	PTX-516	6-06-79	0.02	0.04	0.74	228.9	8.52	143.463	0.715
8	HFET	PTX-516	6-13-79	0.05	0.04	0.85	224.7	8.37	180.032	1.029
8-2	HFET	PTX-516	7-26-79	0.01	0.11	0.85	230.3	8.57	47.164	0.515
8-3	HFET	PTX-516	7-27-79	0.01	0.10	0.79	226.0	8.41	46.760	0.525

				Individual Hydrocarbon Emissions Rate, mg/km Methane	Ethylene	Ethane	Acetylene	Propane	Propylene	Benzene	Toluene
1	FTP	None	5-31-79	11.31	20.69	0.88	4.29	0	8.02	9.01	0.81
3	FTP	None	6-01-79	12.16	23.65	1.66	5.06	0	7.18	8.06	1.47
5	FTP	PTX-516	6-06-79	15.42	5.12	1.02	0.06	0	0.26	1.47	0.64
7	FTP	PTX-516	6-13-79	11.00	6.65	2.05	0.06	0.50	0.87	1.37	1.12
2	HFET	None	5-31-79	2.30	6.96	0.25	1.43	0	2.36	2.49	0
4	HFET	None	6-01-79	2.42	6.52	0.19	1.30	0	2.36	2.61	0.50
6	HFET	PTX-516	6-06-79	3.36	0.37	0.19	0	0	0	0	0
8	HFET	PTX-516	6-13-79	2.24	0.62	0.44	0	0	0	0	0

				Aldehydes Emissions Rates, mg/km Form-Aldehyde	Acet-Aldehyde	Acetone[2]	Isobutyr-Aldehyde	Methyethl Ketone	Croton-Aldehyde	Hex-Aldehyde	Benzene	Total
1	FTP	None	5-31-79	3.4	1.2	0.1	2.1	0	0	0	0	6.8
3	FTP	None	6-01-79	6.1	0.9	0.8	0	0	0.2	0	0.9	8.9
5	FTP	PTX-516	6-06-79	1.1	0.6	0	0	0	0	0	1.6	3.3
7	FTP	PTX-516	6-13-79	2.4	0.7	0	0	0	0	0	0.4	3.5

[2] - Includes acrolein and propanol

The particulate emission rate increased approximately 4 percent using the catalysts. One possible explanation for the increase in particulate rates is that the increase of sulfate emissions with an oxidation type catalyst contributed to the total particulate.

2. HFET Results

All the emissions results obtained during the HFET are also summarized in Table 6. The catalytic converters indicated an improvement in emissions performance over the FTP by reducing CO by approximately 90 percent and HC by 75 percent. The NO_x emissions increased an average of 17 percent. The fuel economy again was not affected. Tables A-1 through A-4 in Appendix A contain the computer printouts for additional information. Tables A-5 and A-6 were reruns to confirm earlier HFET results.

The reduction in individual hydrocarbons indicated the same trends as seen during the FTP. Both methane and ethane did not seem to be affected by the dual exhaust converters. The remaining hydrocarbons were greatly reduced, however. Aldehyde data was not collected during the HFET because the briefness of the cycle would not permit a sufficient amount of sample to be collected.

The particulate rates for the two initially performed tests (Tests 6 and 8) indicated a twofold increase in particulate over the baseline tests. The sulfate emissions increased 30 times the baseline emissions. Both tests showed good repeatability in regulated gaseous emissions, but a lack of repeatability with particulate and sulfate emissions. The activity of the catalyst during the HFET was in the same ballpark of that seen during the FTP.

After the entire schedule for this research effort was completed and all the results reviewed, it was decided to rerun Test 8. The rerun, Test 8-2, showed particulate emission rate and sulfate emissions consistent with other data generated during this investigation. A second rerun, Test 8-3, supported these results. Both reruns exhibited an average particulate rate that was 20 percent higher than the baseline rate. The sulfate emissions increased five times with the catalysts. This finding is of some interest since prior work with Diesel cars has shown no significant storage-purge of exhaust particulate.

3. Other Data

During both test cycles, the oxygen concentration of the raw exhaust and measured continuously along with the inlet temperature. The maximum and minimum values of each were tabulated for each cycle. All the values from the strip charts were taken one minute after the beginning of the cycle. The maximum inlet converter temperature was 196°C during the FTP and 277°C during the HFET. The minimum inlet converter temperature was 76°C during the FTP and 127°C during the HFET. These data are presented in Appendix A, Table A-7.

The 20 x 25 cm Pallflex filters were weighed and stored in sealed, nitrogen filled, Tedlar bags at a temperature of -24°C. These filters were shipped to Frank Butler at the EPA, Research Triangle Park facility for testing sample work-up and Ames bioassay analysis. A description of the filters, the code numbers, and filter loadings are listed in Appendix A, Table A-8. Results of the Ames tests indicated no appreciable difference in specific activity between the samples analyzed. The percent of organic extractables ranged from 3.5 to 9.4 percent with no trends apparent.

After the normal scheduled cycles were complete, the vehicle remained on the dynamometer and the back pressure was recorded at the converter inlet during a 31 km per hour cruise condition. It should be noted that the back pressure increased approximately 10 percent when the dual converter system was used. These back pressures are also listed in Appendix A, Table A-8.

B. UOP Catalyst Results

FTP and HFET regulated and several unregulated emission results were obtained along with various related data for both a fresh and aged catalyst.

1. FTP Results

The FTP emission results for both catalysts are listed in Table 7. The fresh UOP catalyst (UOP-103) exhibited good activity by reducing CO by approximately 80 percent and HC by approximately 50 percent. The NO_x emissions increased slightly, about 3 percent. The aged UOP catalyst (UOP-99) exhibited considerably less activity than its fresh counterpart. CO and HC conversions were approximately 40 and 30 percent respectively. The NO_x emissions increased 14 percent. The fuel economy was not affected. The data summarized in Table 7 are from computer printouts included in Appendix B, Tables B-1 through B-7.

All the individual hydrocarbons were reduced during operation with the fresh catalyst, with the exception of methane which remained unchanged. The aged catalyst reduced the individual hydrocarbons but only about half as efficiently as the fresh catalyst. The aldehyde and sulfate emissions for both fresh and aged catalysts did not change appreciably from baseline.

The particulate emission rate decreased slightly with both the fresh and aged catalysts. The lack of increase of sulfate emissions probably accounts for the decrease of the particulate rate.

TABLE 7. FTP, HFET AND PARTICULATE EMISSIONS FROM 1979 OLDSMOBILE DIESEL DELTA 88 WITH AND WITHOUT A CATALYST

Test No.	Cycle	Catalyst	Date	Emissions Rates, g/km HC	CO	NO_x	CO_2	Consumption ℓ/100 km	Sulfate mg/km	Particulate Emission g/km
9-1	FTP	None	7-06-79	0.27	1.18	1.02	340.41	11.12	23.881	0.782
10-1	FTP	UOP-103	7-11-79	0.13	0.18	0.97	324.33	10.54	17.334	0.723
11-1	FTP	UOP-103	7-12-79	0.04	0.23	1.12	327.70	10.64	14.865	0.605[1]
12-1	FTP	None	7-13-79	0.28	1.09	1.01	321.18	10.50	21.073	0.756
13-1	FTP	UOP-99	7-17-79	0.21	0.66	1.16	329.83	10.75	18.115	0.711
14-1	FTP	UOP-99	7-18-79	0.18	0.64	1.14	325.61	10.61	15.296	0.670
11-2	FTP	UOP-103	7-25-79	0.13	0.44	1.11	330.48	10.75	19.897	0.761
9-1	HFET	None	7-06-79	0.14	0.66	0.75	222.0	8.34	19.798	-
10-1	HFET	UOP-103	7-11-79	0.06	0.06	0.70	226.6	8.44	80.219	0.535
11-1	HFET	UOP-103	7-12-79	0.03	0.08	0.75	202.8	7.55	30.864	0.410
12-1	HFET	None	7-13-79	0.10	0.61	0.75	212.8	7.96	17.098	0.452
13-1	HFET	UOP-99	7-17-79	0.03	0.20	0.84	222.8	8.30	30.160	0.467
14-1	HFET	UOP-99	7-18-79	0.07	0.28	10.81	224.2	8.36	34.930	0.505
11-2	HFET	UOP-103	7-25-79	0.05	0.11	0.80	227.4	8.47	48.792	0.511
14-2	HFET	UOP-99	7-25-79	0.06	0.31	0.87	235.5	8.78	60.723	0.513

				Individual Hydrocarbon Emissions Rate, mg/km Methane	Ethylene	Ethane	Acetylene	Propane	Propylene	Benzene	Toluene
9-1	FTP	None	7-06-79	12.21	24.03	2.33	4.74	0	7.83	10.01	3.01
10-1	FTP	UOP-103	7-11-79	8.57	7.19	0.53	0.17	0	1.79	2.23	0.07
11-1	FTP	UOP-103	7-12-79	10.95	9.12	1.09	0.25	0	1.40	3.21	0.17
12-1	FTP	None	7-13-79	11.46	22.63	1.44	4.29	0	6.87	7.25	0.38
13-1	FTP	UOP-99	7-17-79	11.98	16.62	0.90	1.12	0.93	4.55	5.40	0.30
14-1	FTP	UOP-99	7-18-79	10.94	17.31	1.22	1.31	0	4.69	4.70	0.32
9-1	HFET	None	7-06-79	4.56	11.45	0.59	2.19	0	3.29	4.01	1.56
10-1	HFET	UOP-103	7-11-79	3.57	1.61	0.46	0	0	0.09	0.40	0
11-1	HFET	UOP-103	7-12-79	4.22	2.32	0.65	0	0	0.23	0.66	0.23
12-1	HFET	None	7-13-79	3.77	7.89	0.24	1.48	0	2.50	2.36	0.21
13-1	HFET	UOP-99	7-17-79	4.98	4.69	0.50	0.22	0	1.21	1.96	0.32
14-1	HFET	UOP-99	7-18-79	4.55	5.92	0.50	0.22	0	1.34	2.05	0

				Aldehydes Emissions Rates, mg/km Form-Aldehyde	Acet-Aldehyde	Acetone[2]	Isobutyr-Aldehyde	Methyethl Ketone	Croton-Aldehyde	Hex-Aldehyde	Benzene	Total
9-1	FTP	None	7-06-79	4.2	0.9	0	0	0	0	0	0.6	5.8
10-1	FTP	UOP-103	7-11-79	3.1	0.7	0	0.6	0	0	0	0	4.4
11-1	FTP	UOP-103	7-12-79	2.9	0.9	0.4	0	0	0	0	0	4.2
12-1	FTP	None	7-13-79	4.9	0.1	0	0	0	0	0	0	5.0
13-1	FTP	UOP-99	7-17-79	4.5	0	0	0	0	0.2	0	0.2	4.9
14-1	FTP	UOP-99	7-18-79	5.3	0	0	1.6	0	0	0	1.2	8.1

[1] - Piece of filter missing during weighing
[2] - Includes Acrolein and Propanol

2. HFET Results

The HFET results are listed in Table 7. As seen before, both fresh and aged catalysts showed improved activity during the HFET cycle. The fresh catalyst reduced CO approximately 85 percent and HC by 65 percent. The NO_x emissions remained the same. The aged catalyst, as in the FTP, displayed poorer activity than the fresh catalyst by reducing CO by approximately 60 percent and HC by approximately 55 percent. The NO_x emissions increased by 12 percent. As previously mentioned in this report, the fuel economy remained unchanged. The computer printouts of these HFET results are in Appendix B, Tables B-1 through B-7, alongside the FTP results.

The individual hydrocarbon results support trends seen during the FTP. The fresh and aged catalyst both reduced the individual hydrocarbons, except methane, by a small degree. It should be noted that the baseline individual hydrocarbon emissions during the HFET were approximately half of those seen during the FTP. As stated earlier, no aldehyde emission rates were determined during the HFET.

The particulate emission rate increased approximately 6 percent during the fresh catalyst operation. The sulfate emissions from the same catalyst were increased approximately 50 percent. These results are contrary to those seen during the FTP. The aged catalyst indicated a similar response. It appears that the direction of total particulate emissions follow the direction of sulfate emissions but not necessarily in a quantitative sense.

3. Other Data

As discussed earlier in this report, other data were collected and are listed in Appendix B, Tables B-9 and B-10. This data includes inlet oxygen concentrations, inlet and outlet temperatures, 20 x 25 cm filter information, and exhaust back pressures during the various cycles. The Ames results again indicated no appreciable difference in the samples analyzed. The percent of organic extractables ranged from 4.4 to 6.8 percent. The maximum converter inlet temperature was 271°C during the FTP and 289°C during the HFET. The minimum inlet temperature was 100°C during the FTP and 152°C during the HFET.

C. Discussion

There is a tendency to consider oxidation catalysts as particulate traps. While it is true that a Diesel particulate trap may incorporate one or more washcoats of an oxidizing type catalyst and thereby combine the best features of both for particulate reduction, this type system was not evaluated in this project. The converters employed were Diesel versions of the standard monolithic type substrate and arrangement popularly used for control of HC and CO from gasoline burning cars and light trucks since the 1975 model year. It is evident that these oxidation type catalytic

converters did a substantial job on reducing both HC and CO, both items for which they were intended. In so doing, however, substantial increases in sulfate resulted. These three findings, lower HC and CO and higher sulfate, were as anticipated from experiment.

What small improvements in particulate that may have occurred due to a reduction in gas phase HC was more than offset by the substantial increases in sulfate. Thus, on the surface, the use of oxidation catalysts are of questionable value for the Diesel car. Improvements in CO are not needed, since the Diesel CO is already very low and the trade-off of lower HC for higher sulfates and possibly even higher NO_x seems tenuous at best.

The use of the catalyst coatings on particulate traps and substrates specifically designed to collect and burn-off is of major importance. Based on the one vehicle tested, the future of catalysts in Diesel exhaust applications appears to be tied to the development of workable particulate trap systems. No attempt was made to investigate or study any possible storage and purge mechanisms of exhaust compounds from systems employing monolithic oxidation type catalysts.

REFERENCES

1. Federal Register, Volume 42, No. 124, Part III, June 28, 1977.

2. Federal Register, Volume 44, No. 23, Part IV, February 1, 1979.

3. Analytical Procedures for Characterizing Unregulated Pollutant Emissions from Motor Vehicles, Environmental Sciences Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, February 1979.

4. Methodology for Determining Fuel Effects on Diesel Particulate Emissions, Chemistry and Physics Laboratory, National Environmental Research Center, Research Triangle Park, North Carolina, March 1975.

5. Federal Register, Volume 43, No. 140, July 20, 1978.

6. 55 mph Alternate Mileage Accumulation Procedure (MSAPC A/C No. 37, December 20, 1973, Enclosure 1).

APPENDIX A

BASELINE, FTP AND HFET RESULTS
ENGELHARD CATALYTIC CONVERTER SYSTEM

TABLE A-1. VEHICLE EMISSION RESULTS
FTPC + HFET

PROJECT NO. 11-4311-003

VEHICLE NO. 1
VEHICLE MODEL 79 BLUE OLDS NO.1
ENGINE 0.0 L(-0 CID) V8
TRANSMISSION A3
GVW 0 KG(-0 LBS)

TEST NO. 1 RUN 1
DATE 5/31/79
TIME 11:36
DYNO NO. 2
CVS NO. 1
BAG CART NO. 1

TEST WEIGHT 1818 KG(4000 LBS)
ACTUAL ROAD LOAD 9.1 KW(12.2 HP)
DIESEL EM-321F
ODOMETER 697

BAROMETER 739.90 MM HG(29.13 IN HG)
DRY BULB TEMP. 23.3 DEG C(74.0 DEG F)

RELATIVE HUMIDITY 44 PCT
ABSOLUTE HUMIDITY 8.0 GM/KG(55.9 GRAINS/LB)

NOX HUMIDITY C.F. .9177

BAG RESULTS

	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	HFET
BAG NUMBER				
DESCRIPTION				
BLOWER DIF P MM. H2O(IN. H2O)	508.0 (20.0)	508.0 (20.0)	508.0 (20.0)	508.0 (20.0)
BLOWER INLET P MM. H2O(IN. H2O)	419.1 (16.5)	419.1 (16.5)	419.1 (16.5)	419.1 (16.5)
BLOWER INLET TEMP. DEG. C(DEG. F)	44.4 (112.0)	43.3 (110.0)	43.3 (110.0)	43.9 (111.0)
BLOWER REVOLUTIONS	9242	15958	9291	14069
CVS FLOW STD. CU. METRES(SCF)	135.3 (4778.6)	234.4 (8279.3)	136.5 (4820.0)	206.3 (7287.7)
HC SAMPLE METER/RANGE/PPM	7.7/13/ 31	11.6/12/ 23	11.5/12/ 23	12.7/12/ 25
HC BCKGRD METER/RANGE/PPM	5.2/ 2/ 10	5.2/ 2/ 10	5.2/ 2/ 10	5.5/ 2/ 11
CO SAMPLE METER/RANGE/PPM	69.3/13/ 62	93.0/13/ 91	97.9/13/ 96	57.2/13/ 55
CO BCKGRD METER/RANGE/PPM	14.0/13/ 13	11.3/13/ 11	5.3/13/ 5	4.2/13/ 4
CO2 SAMPLE METER/RANGE/PCT	99.6/ 3/ .86	34.5/ 3/ .58	44.8/ 3/ .77	60.0/ 3/ 1.06
CO2 BCKGRD METER/RANGE/PCT	5.2/ 3/ .08	5.2/ 3/ .08	4.2/ 3/ .06	4.1/ 3/ .06
NOX SAMPLE METER/RANGE/PPM	21.4/ 2/ 21	17.0/ 2/ 17	21.9/ 2/ 22	32.4/ 2/ 32
NOX BCKGRD METER/RANGE/PPM	1.5/ 2/ 2	1.6/ 2/ 2	1.4/ 2/ 1	1.8/ 2/ 2
DILUTION FACTOR	15.43	22.99	17.30	12.51
HC CONCENTRATION PPM	21	13	13	15
CO CONCENTRATION PPM	48	29	39	49
CO2 CONCENTRATION PCT	.78	.50	.71	1.01
NOX CONCENTRATION PPM	20.0	15.5	20.6	30.7
HC MASS GRAMS	1.66	1.80	1.09	1.81
CO MASS GRAMS	7.56	8.05	6.27	11.84
CO2 MASS GRAMS	1993.8	2196.5	1766.9	3797.7
NOX MASS GRAMS	9.75	6.37	9.93	11.19
HC GRAMS/KM (GRAMS/MILE)	.28 (.45)	.29 (.46)	.18 (.29)	.11 (.18)
CO GRAMS/KM (GRAMS/MILE)	1.28 (2.06)	1.29 (2.07)	1.07 (1.73)	.71 (1.15)
CO2 GRAMS/KM (GRAMS/MILE)	329.8 (530.7)	342.8 (551.6)	302.3 (486.5)	228.5 (367.6)
NOX GRAMS/KM (GRAMS/MILE)	.81 (1.30)	1.02 (1.64)	.84 (1.36)	.67 (1.08)
FUEL CONSUMPTION BY CB L/100KM(MPG)	12.38 (19.01)	12.86 (18.29)	11.33 (20.76)	8.55 (27.51)
CALCULATED DISTANCE KM (MILES)	5.89 (3.66)	6.26 (3.89)	5.84 (3.63)	14.62 (10.33)

COMPOSITE FTP RESULTS

HC GRAMS/KM (GRAMS/MILE)	.26 (.41)
CO GRAMS/KM (GRAMS/MILE)	1.23 (1.97)
CO2 GRAMS/KM (GRAMS/MILE)	328.98 (529.32)
NOX GRAMS/KM (GRAMS/MILE)	.93 (1.49)
FUEL CONSUMPTION BY CB L/100KM (MPG)	10.75 (21.88)
COMBINED FUEL ECONOMY L/100KM (MPG)	9.76 (24.10)

TABLE A-2. VEHICLE EMISSION RESULTS
FTP HFET

PROJECT NO. 11-4311-003

VEHICLE NO. 1
VEHICLE MODEL 79 BLUE OLDS NO.1
ENGINE 0.0 L(-0 CID) V-8
TRANSMISSION A3
GVW 0 KG(-0 LBS)

TEST NO. 1 RUN 3
DATE 6/ 1/79
TIME 11:37
DYNO NO. 2
CVS NO. 1
BAG CART NO. 1

TEST WEIGHT 1818 KG(4000 LBS)
ACTUAL ROAD LOAD 9.1 KW(12.2 HP)
DIESEL EM-321F
ODOMETER 720

BAROMETER 742.95 MM HG(29.25 IN HG)
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)

RELATIVE HUMIDITY 52 PCT
ABSOLUTE HUMIDITY 10.6 GM/KG(74.3 GRAINS/LB) NOX HUMIDITY C.F. .9967

BAG RESULTS

	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	HFET
BAG NUMBER				
DESCRIPTION				
BLOWER DIF P MM. H2O(IN. H2O)	508.0 (20.0)	508.0 (20.0)	508.0 (20.0)	508.0 (20.0)
BLOWER INLET P MM. H2O(IN. H2O)	431.8 (17.0)	431.8 (17.0)	431.8 (17.0)	431.8 (17.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	43.3 (110.0)	43.3 (110.0)	43.3 (110.0)	45.0 (113.0)
BLOWER REVOLUTIONS	9339	16027	9326	19140
CVS FLOW STD. CU. METRES(SCF)	137.6 (4860.0)	236.2 (8343.2)	137.5 (4855.0)	207.5 (7328.1)
HC SAMPLE METER/RANGE/PPM	19.8/12/ 30	9.7/12/ 19	11.5/12/ 23	12.9/12/ 24
HC BCKGRD METER/RANGE/PPM	6.5/ 2/ 13	6.5/ 2/ 13	7.0/ 2/ 14	7.0/ 2/ 14
CO SAMPLE METER/RANGE/PPM	56.0/13/ 59	35.1/13/ 33	45.6/13/ 43	55.9/13/ 53
CO BCKGRD METER/RANGE/PPM	9.9/13/ 9	3.5/13/ 3	2.9/13/ 3	2.5/13/ 2
CO2 SAMPLE METER/RANGE/PCT	48.5/ 3/ .89	32.9/ 3/ .59	44.1/ 3/ .79	60.1/ 3/ 1.06
CO2 BCKGRD METER/RANGE/PCT	3.9/ 3/ .05	3.8/ 3/ .06	3.9/ 3/ .06	3.9/ 3/ .06
NOX SAMPLE METER/RANGE/PPM	21.5/ 2/ 21	17.8/ 2/ 18	23.3/ 2/ 23	37.7/ 2/ 38
NOX BCKGRD METER/RANGE/PPM	2.8/ 2/ 3	3.2/ 2/ 3	3.6/ 2/ 4	1.1/ 2/ 1
DILUTION FACTOR	15.83	24.64	17.61	12.49
HC CONCENTRATION PPM	18	7	10	13
CO CONCENTRATION PPM	48	29	34	49
CO2 CONCENTRATION PCT	.79	.48	.70	1.01
NOX CONCENTRATION PPM	18.9	14.7	19.9	34.7
HC MASS GRAMS	1.39	.95	.77	1.53
CO MASS GRAMS	7.68	8.00	6.29	11.80
CO2 MASS GRAMS	1989.9	2088.2	1757.3	3837.2
NOX MASS GRAMS	9.95	6.63	5.22	14.51
HC GRAMS/KM (GRAMS/MILE)	.24 (.38)	.15 (.24)	.13 (.20)	.09 (.15)
CO GRAMS/KM (GRAMS/MILE)	1.31 (2.10)	1.27 (2.05)	1.03 (1.66)	.71 (1.14)
CO2 GRAMS/KM (GRAMS/MILE)	338.5 (544.6)	332.3 (534.6)	287.6 (462.8)	230.7 (371.2)
NOX GRAMS/KM (GRAMS/MILE)	.84 (1.36)	1.06 (1.70)	.85 (1.37)	.87 (1.40)
FUEL CONSUMPTION BY CB L/100KM(MPG)	12.69 (18.53)	12.45 (18.89)	10.77 (21.83)	8.63 (27.24)
CALCULATED DISTANCE KM (MILES)	5.88 (3.65)	6.29 (3.91)	6.11 (3.80)	14.63 (10.34)

COMPOSITE FTP RESULTS

		*CORRECTED COMPOSTIE FTP RESULTS	
HC GRAMS/KM (GRAMS/MILE)	.16 (.26)	.17	(.27)
CO GRAMS/KM (GRAMS/MILE)	1.21 (1.95)	1.25	(2.01)
CO2 GRAMS/KM (GRAMS/MILE)	321.01 (516.50)	330.58	(532.00)
NOX GRAMS/KM (GRAMS/MILE)	.95 (1.54)	.99	(1.59)
FUEL CONSUMPTION BY CB L/100KM (MPG)	10.48 (22.44)	10.79	(21.77)
COMBINED FUEL ECONOMY L/100KM (MPG)	9.65 (24.37)	9.83	(23.93)

*RESULTS ADJUSTED TO INCLUDE SAMPLE PROBE FLOW RATES

TABLE A-3. VEHICLE EMISSION RESULTS
FTPC HFET

PROJECT NO. 11-9311-013

VEHICLE NO. 1
VEHICLE MODEL 79 BLUE OLDS NO.1
ENGINE 8.0 L(490 CID) V-8
TRANSMISSION A3
GVW 0 KG(0 LBS)

TEST NO. 2 RUN 1
DATE 6/ 6/79
TIME 09:50
DYNO NO. 2
CVS NO. 1
BAG CART NO. 1

TEST WEIGHT 1818 KG(4000 LBS)
ACTUAL ROAD LOAD 9.1 KW(12.2 HP)
DIESEL EM-321-F
ODOMETER 1265

BAROMETER 738.38 MM HG(29.07 IN HG)
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)

RELATIVE HUMIDITY 60 PCT
ABSOLUTE HUMIDITY 12.2 GM/KG(85.2 GRAINS/LB) NOX HUMIDITY C.F. 1.0503

BAG RESULTS

	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	HFET
BAG NUMBER				
DESCRIPTION				
BLOWER DIF P MM. H2O(IN. H2O)	508.0 (20.0)	508.0 (20.0)	508.0 (20.0)	508.0 (20.0)
BLOWER INLET P MM. H2O(IN. H2O)	431.8 (17.0)	431.8 (17.0)	431.8 (17.0)	431.8 (17.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	36.1 (97.0)	37.8 (100.0)	35.6 (96.0)	40.6 (105.0)
BLOWER REVOLUTIONS	9339	16138	9352	14155
CVS FLOW STD. CU. METRES(SCF)	139.3 (9919.9)	239.8 (8470.4)	139.7 (9932.8)	208.8 (7373.7)
HC SAMPLE METER/RANGE/PPM	6.5/12/ 13	6.7/12/ 13	6.6/12/ 13	5.7/12/ 11
HC BCKGRD METER/RANGE/PPM	4.5/ 2/ 4	4.5/ 2/ 4	4.5/ 2/ 4	5.0/ 2/ 10
CO SAMPLE METER/RANGE/PPM	11.0/13/ 11	4.7/13/ 5	5.8/13/ 6	5.3/13/ 5
CO BCKGRD METER/RANGE/PPM	3.1/13/ 3	2.7/13/ 3	2.5/13/ 2	2.3/13/ 2
CO2 SAMPLE METER/RANGE/PCT	96.0/ 3/ .79	31.7/ 3/ .53	92.7/ 3/ .73	58.6/ 3/ 1.09
CO2 BCKGRD METER/RANGE/PCT	3.3/ 3/ .05	3.4/ 3/ .05	3.4/ 3/ .05	3.7/ 3/ .06
NOX SAMPLE METER/RANGE/PPM	19.7/ 2/ 20	15.4/ 2/ 15	19.3/ 2/ 19	30.2/ 2/ 30
NOX BCKGRD METER/RANGE/PPM	.8/ 2/ 1	.6/ 2/ 1	.6/ 2/ 1	1.2/ 2/ 1
DILUTION FACTOR	16.90	25.39	18.35	12.92
HC CONCENTRATION PPM	9	5	5	2
CO CONCENTRATION PPM	7	2	3	3
CO2 CONCENTRATION PCT	.79	.98	.68	.98
NOX CONCENTRATION PPM	18.9	14.8	18.7	29.1
HC MASS GRAMS	.36	.66	.38	.26
CO MASS GRAMS	1.21	.55	.52	.71
CO2 MASS GRAMS	1895.9	2090.6	1736.5	3757.6
NOX MASS GRAMS	5.30	7.14	5.26	12.20
HC GRAMS/KM (GRAMS/MILE)	.06 (.10)	.11 (.17)	.07 (.11)	.02 (.03)
CO GRAMS/KM (GRAMS/MILE)	.21 (.34)	.09 (.14)	.09 (.14)	.04 (.07)
CO2 GRAMS/KM (GRAMS/MILE)	327.9 (526.9)	336.7 (541.7)	301.1 (484.4)	228.9 (368.3)
NOX GRAMS/KM (GRAMS/MILE)	.92 (1.47)	1.15 (1.85)	.91 (1.47)	.74 (1.20)
FUEL CONSUMPTION BY CB L/100KM(MPG)	12.20 (19.28)	12.59 (18.76)	11.21 (20.98)	8.52 (27.62)
CALCULATED DISTANCE KM (MILES)	5.79 (3.60)	6.21 (3.86)	5.77 (3.58)	16.92 (10.20)

COMPOSITE FTP RESULTS

		*CORRECT COMPOSITE FTP RESULTS	
HC GRAMS/KM (GRAMS/MILE)	.09 (.14)	.09	(0.14)
CO GRAMS/KM (GRAMS/MILE)	.11 (.18)	.12	(0.19)
CO2 GRAMS/KM (GRAMS/MILE)	329.99 (522.92)	334.69	(538.61)
NOX GRAMS/KM (GRAMS/MILE)	1.04 (1.67)	1.07	(1.72)
FUEL CONSUMPTION BY CB L/100KM (MPG)	10.55 (22.30)	10.87	(21.63)
COMBINED FUEL ECONOMY L/100KM (MPG)	9.69 (24.91)	9.81	(23.97)

*RESULTS ADJUSTED TO INCLUDE SAMPLE PROBE FLOW RATES

TABLE A-4. VEHICLE EMISSION RESULTS
FTP FET

PROJECT NO. 11-9311-003

VEHICLE NO. 1
VEHICLE MODEL 79 BLUE OLDS NO.1
ENGINE 0.0 L(-0 CID) V-8
TRANSMISSION A3
GVW 0 KG(-0 LBS)

TEST NO. 2 RUN 2
DATE 6/13/79
TIME 09:25
DYNO NO. 2
CVS NO. 1
BAG CART NO. 1

TEST WEIGHT 1818 KG(4000 LBS)
ACTUAL ROAD LOAD 9.1 KW(12.2 HP)
DIESEL EM-321F
ODOMETER 1893

BAROMETER 745.74 MM HG(29.36 IN HG)
DRY BULB TEMP. 23.9 DEG C(75.0 DEG F)

RELATIVE HUMIDITY 55 PCT
ABSOLUTE HUMIDITY 10.3 GM/KG(72.4 GRAINS/LB)

NOX HUMIDITY C.F. .9877

BAG RESULTS

	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	HFET
BAG NUMBER				
DESCRIPTION				
BLOWER DIF P MM. H2O(IN. H2O)	508.0 (20.0)	508.0 (20.0)	508.0 (20.0)	508.0 (20.0)
BLOWER INLET P MM. H2O(IN. H2O)	931.8 (17.0)	931.8 (17.0)	931.8 (17.0)	931.8 (17.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	43.3 (110.0)	42.2 (108.0)	43.3 (110.0)	43.3 (110.0)
BLOWER REVOLUTIONS	9358	16002	9332	19199
CVS FLOW STD. CU. METRES(SCF)	138.5 (4893.1)	237.5 (8388.9)	138.1 (4878.3)	209.3 (7393.9)
HC SAMPLE METER/RANGE/PPM	8.3/12/ 17	5.6/12/ 11	5.2/12/ 10	5.7/12/ 11
HC BCKGRD METER/RANGE/PPM	3.6/ 2/ 7	3.5/ 2/ 7	3.6/ 2/ 7	2.5/ 2/ 5
CO SAMPLE METER/RANGE/PPM	12.7/13/ 12	4.8/13/ 5	6.9/13/ 7	4.8/13/ 5
CO BCKGRD METER/RANGE/PPM	2.4/13/ 2	2.2/13/ 2	3.1/13/ 3	2.4/13/ 2
CO2 SAMPLE METER/RANGE/PCT	98.7/ 3/ .84	32.5/ 3/ .54	93.8/ 3/ .75	57.7/ 3/ 1.02
CO2 BCKGRD METER/RANGE/PCT	3.1/ 3/ .05	3.5/ 3/ .05	4.0/ 3/ .06	3.7/ 3/ .06
NOX SAMPLE METER/RANGE/PPM	29.0/ 2/ 29	18.2/ 2/ 18	29.4/ 2/ 29	36.7/ 2/ 37
NOX BCKGRD METER/RANGE/PPM	1.4/ 2/ 1	1.2/ 2/ 1	1.6/ 2/ 2	1.5/ 2/ 2
DILUTION FACTOR	15.86	24.72	17.85	13.15
HC CONCENTRATION PPM	10	4	4	7
CO CONCENTRATION PPM	10	3	4	2
CO2 CONCENTRATION PCT	.80	.44	.69	.96
NOX CONCENTRATION PPM	22.7	17.0	22.4	35.3
HC MASS GRAMS	.78	.58	.29	.83
CO MASS GRAMS	1.55	.70	.54	.58
CO2 MASS GRAMS	2023.7	2126.4	1747.6	3699.4
NOX MASS GRAMS	5.44	7.65	5.47	13.47
HC GRAMS/KM (GRAMS/MILE)	.13 (.22)	.09 (.15)	.05 (.08)	.05 (.08)
CO GRAMS/KM (GRAMS/MILE)	.27 (.43)	.11 (.18)	.10 (.17)	.04 (.06)
CO2 GRAMS/KM (GRAMS/MILE)	348.6 (560.4)	342.7 (551.4)	303.4 (488.2)	224.7 (361.6)
NOX GRAMS/KM (GRAMS/MILE)	1.02 (1.65)	1.23 (1.98)	1.04 (1.67)	.85 (1.37)
FUEL CONSUMPTION BY CB L/100KM(MPG)	13.00 (18.10)	12.76 (18.43)	11.30 (20.82)	8.37 (28.12)
CALCULATED DISTANCE KM (MILES)	5.81 (3.61)	6.21 (3.86)	5.76 (3.58)	16.46 (10.23)

COMPOSITE FTP RESULTS

HC GRAMS/KM (GRAMS/MILE)	.09 (.14)
CO GRAMS/KM (GRAMS/MILE)	.14 (.23)
CO2 GRAMS/KM (GRAMS/MILE)	333.14 (536.03)
NOX GRAMS/KM (GRAMS/MILE)	1.14 (1.83)
FUEL CONSUMPTION BY CB L/100KM (MPG)	10.92 (21.75)
COMBINED FUEL ECONOMY L/100KM (MPG)	9.71 (24.22)

TABLE A-5. VEHICLE EMISSION RESULTS

FET

PROJECT NO. 11-9311-003

VEHICLE NO.	1	TEST NO. 8 RUN 2	TEST WEIGHT 1818 KG(4000 LBS)
VEHICLE MODEL	79 BLUE OLDS NO.1	DATE 7/26/79	ACTUAL ROAD LOAD 1.6 KW(2.2 HP)
ENGINE	4.0 L(0 CID) V-8	TIME 09:45	DIESEL EM-321-F
TRANSMISSION	A3	DYNO NO. 2	ODOMETER 2799
GVW	0 KG(0 LBS)	CVS NO. 1	
		BAG CART NO. 1	

BAROMETER 739.14 MM HG(29.10 IN HG)
DRY BULB TEMP. 27.2 DEG C(81.0 DEG F)

RELATIVE HUMIDITY 58 PCT
ABSOLUTE HUMIDITY 13.5 GM/KG(94.6 GRAINS/LB)

NOX HUMIDITY C.F. 1.1015

BAG RESULTS	HFET
BAG NUMBER	
BLOWER DIF P MM. H2O(IN. H2O)	457.2 (18.0)
BLOWER INLET P MM. H2O(IN. H2O)	419.1 (16.5)
BLOWER INLET TEMP. DEG. C(DEG. F)	46.1 (115.0)
BLOWER REVOLUTIONS	14229
CVS FLOW STD. CU. METRES(SCF)	208.2 (7353.5)
HC SAMPLE METER/RANGE/PPM	5.2/12/ 10
HC BCKGRD METER/RANGE/PPM	4.8/ 2/ 10
CO SAMPLE METER/RANGE/PPM	9.3/13/ 8
CO BCKGRD METER/RANGE/PPM	1.0/13/ 1
CO2 SAMPLE METER/RANGE/PCT	58.1/ 3/ 1.03
CO2 BCKGRD METER/RANGE/PCT	3.1/ 3/ .05
NOX SAMPLE METER/RANGE/PPM	32.8/ 2/ 33
NOX BCKGRD METER/RANGE/PPM	1.6/ 2/ 2
DILUTION FACTOR	13.05
HC CONCENTRATION PPM	2
CO CONCENTRATION PPM	7
CO2 CONCENTRATION PCT	.98
NOX CONCENTRATION PPM	31.3
HC MASS GRAMS	.19
CO MASS GRAMS	1.71
CO2 MASS GRAMS	3742.2
NOX MASS GRAMS	13.74
HC GRAMS/KM (GRAMS/MILE)	.01 (.02)
CO GRAMS/KM (GRAMS/MILE)	.11 (.17)
CO2 GRAMS/KM (GRAMS/MILE)	230.3 (370.5)
NOX GRAMS/KM (GRAMS/MILE)	.85 (1.36)
FUEL CONSUMPTION BY CB L/100KM(MPG)	8.57 (27.44)
CALCULATED DISTANCE KM (MILES)	16.25 (10.10)

TABLE A-6. VEHICLE EMISSION RESULTS
FET

PROJECT NO. 11-4311-003

VEHICLE NO.	1	TEST NO.	8 RUN 3
VEHICLE MODEL	79 BLUE OLDS NO.1	DATE	7/27/79
ENGINE 8.0 L(-0 CID) V-8		TIME	15:37
TRANSMISSION A3		DYNO NO.	2
GVW	0 KG(-0 LBS)	CVS NO.	1
		BAG CART NO.	1
		TEST WEIGHT	1818 KG(4000 LBS)
		ACTUAL ROAD LOAD	9.1 KW(12.2 HP)
		DIESEL	EM-321F
		ODOMETER	2823

BAROMETER 739.39 MM HG(29.11 IN HG)
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)

RELATIVE HUMIDITY 63 PCT
ABSOLUTE HUMIDITY 12.9 GM/KG(90.4 GRAINS/LB)

NOX HUMIDITY C.F. 1.0779

BAG RESULTS

	HFET
BAG NUMBER	
BLOWER DIF P MM. H2O(IN. H2O)	457.2 (18.0)
BLOWER INLET P MM. H2O(IN. H2O)	419.1 (16.5)
BLOWER INLET TEMP. DEG. C(DEG. F)	46.1 (115.0)
BLOWER REVOLUTIONS	14263
CVS FLOW STD. CU. METRES(SCF)	208.9 (7378.7)
HC SAMPLE METER/RANGE/PPM	5.2/12/ 10
HC BCKGRD METER/RANGE/PPM	4.8/ 2/ 10
CO SAMPLE METER/RANGE/PPM	8.1/13/ 7
CO BCKGRD METER/RANGE/PPM	.9/13/ 0
CO2 SAMPLE METER/RANGE/PCT	57.5/ 3/ 1.01
CO2 BCKGRD METER/RANGE/PCT	3.1/ 3/ .05
NOX SAMPLE METER/RANGE/PPM	30.9/ 2/ 31
NOX BCKGRD METER/RANGE/PPM	.8/ 2/ 1
DILUTION FACTOR	13.20
HC CONCENTRATION PPM	2
CO CONCENTRATION PPM	6
CO2 CONCENTRATION PCT	.97
NOX CONCENTRATION PPM	30.2
HC MASS GRAMS	.19
CO MASS GRAMS	1.58
CO2 MASS GRAMS	3709.5
NOX MASS GRAMS	12.99
HC GRAMS/KM (GRAMS/MILE)	.01 (.02)
CO GRAMS/KM (GRAMS/MILE)	.10 (.15)
CO2 GRAMS/KM (GRAMS/MILE)	226.0 (363.7)
NOX GRAMS/KM (GRAMS/MILE)	.79 (1.27)
FUEL CONSUMPTION BY CB L/100KM(MPG)	8.91 (27.96)
CALCULATED DISTANCE KM (MILES)	16.91 (10.20)

TABLE A-7. ENGELHARD CATALYTIC CONVERTERS
CONVERTERS INLET OXYGEN AND TEMPERATURE

Cycle		Catalyst	Date	Inlet Temperature, °C		Percent O_2	
				Left	Right	Left	Right
FTP	MAX	None	5-31-79	273	241	18.56	18.26
	MIN			157	113	6.30	8.25
HFET	MAX	None	5-31-79	296	264	18.71	18.51
	MIN			202	177	9.50	11.33
FTP	MAX	None	6-01-79	254	242	18.76	18.56
	MIN			119	103	5.75	6.70
HFET	MAX	None	6-01-79	277	261	18.71	18.51
	MIN			179	162	9.75	10.83
FTP	MAX	PTX-516	6-06-79	193	223	18.76	18.68
	MIN			76	98	7.00	7.50
HFET	MAX	PTX-516	6-06-79	223	248	18.51	18.53
	MIN			127	147	9.83	10.30
FTP	MAX	PTX-516	6-13-79	196	222	18.76	18.83
	MIN			86	91	7.18	7.38
HFET	MAX	PTX-516	6-13-79	235	250	18.51	18.53
	MIN			151	162	10.00	10.18

TABLE A-8. DUAL ENGELHARD CATALYTIC CONVERTERS
EXHAUST BACK PRESSURES DURING 31 km/hr CRUISE

Catalyst	Date	Exhaust Back Pressure, kPa Left Bank	Right Bank
None	6-01-79	9.45	9.45
PTX-516	6-06-79	11.48	11.48
PTX-516	6-13-79	14.86	14.18

20x25 cm Particulate Filters

Type Test	Catalyst	Date	Filter No.	Filter Loading, mg
Cold FTP	None	6-01-79	PL-1506	114.5
Hot FTP	None	6-01-79	PL-1507	152.0
Hot FTP	None	6-01-79	PL-1509	165.7
Cold FTP	PTX-516	6-06-79	PL-1510	229.7
Hot FTP	PTX-516	6-06-79	PL-1511	166.6
Hot FTP	PTX-516	6-06-79	PL-1512	167.0
Cold FTP	None	6-27-79	PL-1514	165.8
Hot FTP	None	6-27-79	PL-1515	188.0
Hot FTP	None	6-27-79	PL-1516	180.5

APPENDIX B

BASELINE, FTP AND HFET RESULTS
UOP CATALYTIC CONVERTER SYSTEM

TABLE B-1. VEHICLE EMISSION RESULTS
FTP HFET

PROJECT NO. 11-4311-003

VEHICLE NO.
VEHICLE MODEL 79 OLDS DIESEL
ENGINE 5.7 L(350 CID) V-8
TRANSMISSION A3
GVW 0 KG(-0 LBS)

TEST NO. 9-1 RUN 1
DATE 7/ 6/79
TIME
DYNO NO. 2
CVS NO. 1
BAG CART NO. 1

TEST WEIGHT 1818 KG(4000 LBS)
ACTUAL ROAD LOAD 9.1 KW(12.2 HP)
DIESEL EM-321-F
ODOMETER 1922

BAROMETER 742.20 MM HG(29.24 IN HG)
DRY BULB TEMP. 25.4 DEG C(78.0 DEG F)

RELATIVE HUMIDITY 60 PCT
ABSOLUTE HUMIDITY 12.6 GM/KG(88.2 GRAINS/LB)

NOX HUMIDITY C.F. 1.0661

BAG RESULTS

	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	HFET
BAG NUMBER				
DESCRIPTION				
BLOWER DIF P MM. H2O(IN. H2O)	515.6 (20.3)	515.6 (20.3)	515.6 (20.3)	508.0 (20.0)
BLOWER INLET P MM. H2O(IN. H2O)	431.8 (17.0)	431.8 (17.0)	431.8 (17.0)	419.1 (16.5)
BLOWER INLET TEMP. DEG. C(DEG. F)	38.3 (101.0)	38.3 (101.0)	40.6 (105.0)	52.8 (127.0)
BLOWER REVOLUTIONS	9310	16011	9399	14152
CVS FLOW STD. CU. METERS(SCF)	138.9 (4904.9)	238.8 (8434.5)	139.5 (4927.1)	203.2 (7176.1)
HC SAMPLE METER/RANGE/PPM	14.8/12/ 34	12.2/12/ 24	11.1/12/ 22	14.0/12/ 28
HC BCKGRD METER/RANGE/PPM	5.8/ 2/ 12	6.0/ 2/ 12	6.1/ 2/ 12	5.1/ 2/ 10
CO SAMPLE METER/RANGE/PPM	46.7/13/ 44	30.5/13/ 28	39.4/13/ 36	50.6/13/ 48
CO BCKGRD METER/RANGE/PPM	.3/13/ 0	.1/13/ 0	.1/13/ 0	.8/13/ 1
CO2 SAMPLE METER/RANGE/PCT	46.5/ 3/ .40	31.5/ 3/ .52	42.9/ 3/ .73	58.2/ 3/ 1.03
CO2 BCKGRD METER/RANGE/PCT	2.9/ 3/ .04	3.0/ 3/ .05	2.8/ 3/ .04	3.7/ 3/ .06
NOX SAMPLE METER/RANGE/PPM	18.6/ 2/ 19	14.3/ 2/ 14	18.9/ 2/ 19	30.2/ 2/ 30
NOX BCKGRD METER/RANGE/PPM	.7/ 2/ 1	.8/ 2/ 1	.4/ 2/ 0	.6/ 2/ 1
DILUTION FACTOR	16.59	25.40	18.17	12.95
HC CONCENTRATION PPM	23	13	11	19
CO CONCENTRATION PPM	42	27	35	45
CO2 CONCENTRATION PCT	.76	.48	.69	.97
NOX CONCENTRATION PPM	17.9	13.5	18.5	29.6
HC MASS GRAMS	1.81	1.78	.87	2.19
CO MASS GRAMS	6.78	7.43	5.69	10.71
CO2 MASS GRAMS	1928.7	2092.0	1766.5	3627.5
NOX MASS GRAMS	5.08	6.59	5.27	12.28
HC GRAMS/KM (GRAMS/MILE)	.31 (.51)	.29 (.47)	.15 (.24)	.13 (.22)
CO GRAMS/KM (GRAMS/MILE)	1.18 (1.89)	1.22 (1.96)	1.00 (1.61)	.66 (1.06)
CO2 GRAMS/KM (GRAMS/MILE)	334.7 (538.6)	342.6 (551.2)	310.6 (499.8)	222.8 (358.4)
NOX GRAMS/KM (GRAMS/MILE)	.88 (1.42)	1.08 (1.74)	.93 (1.49)	.75 (1.21)
FUEL CONSUMPTION BY CB L/100KM(MPG)	12.56 (18.74)	12.85 (18.31)	11.43 (20.23)	8.34 (28.21)
CALCULATED DISTANCE KM (MILES)	5.76 (3.58)	6.11 (3.80)	5.69 (3.53)	14.28 (10.12)

COMPOSITE FTP RESULTS

		*CORRECTED COMPOSITE FTP RESULTS	
HC GRAMS/KM (GRAMS/MILE)	.24 (.42)	.27	(.43)
CO GRAMS/KM (GRAMS/MILE)	1.15 (1.85)	1.18	(1.90)
CO2 GRAMS/KM (GRAMS/MILE)	332.15 (534.43)	340.41	(547.81)
NOX GRAMS/KM (GRAMS/MILE)	1.00 (1.60)	1.02	(1.64)
FUEL CONSUMPTION BY CB L/100KM (MPG)	10.85 (21.68)	11.12	(21.03)
COMBINED FUEL ECONOMY L/100KM (MPG)	9.72 (24.20)	9.91	(23.75)

*RESULTS ADJUSTED TO INCLUDE SAMPLE PROBE FLOW RATES

TABLE B-2. VEHICLE EMISSION RESULTS
FTP

PROJECT NO. 11-4311-003

VEHICLE NO. 1
VEHICLE MODEL 79 BLUE OLDS NO.1
ENGINE 0.0 L(-0 CID) V-8
TRANSMISSION A3
GVW 0 KG(-0 LBS)

TEST NO. 10 RUN 1
DATE 7/11/79
TIME 10:27
DYNO NO. 2
CVS NO. 1
BAG CART NO. 1

TEST WEIGHT 1818 KG(4000 LBS)
ACTUAL ROAD LOAD 9.1 KW(12.2 HP)
DIESEL EM-321-F
ODOMETER 2468

BAROMETER 737.62 MM HG(29.04 IN HG)
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)

RELATIVE HUMIDITY 56 PCT
ABSOLUTE HUMIDITY 11.4 GM/KG(80.1 GRAINS/LB)

NOX HUMIDITY C.F. 1.0244

BAG RESULTS

BAG NUMBER	1	2	3	
DESCRIPTION	COLD TRANSIENT	STABILIZED	HOT TRANSIENT	HFET
BLOWER DIF P MM. H2O(IN. H2O)	508.0 (20.0)	508.0 (20.0)	508.0 (20.0)	508.0 (20.0)
BLOWER INLET P MM. H2O(IN. H2O)	431.8 (17.0)	431.8 (17.0)	431.8 (17.0)	431.8 (17.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	37.8 (100.0)	40.0 (104.0)	40.6 (105.0)	43.3 (110.0)
BLOWER REVOLUTIONS	9306	16014	9303	14152
CVS FLOW STD. CU. METRES(SCF)	138.0 (4875.7)	236.2 (8344.0)	137.0 (4839.8)	207.0 (7309.7)
HC SAMPLE METER/RANGE/PPM	9.3/12/ 19	7.5/12/ 15	7.2/12/ 14	7.1/12/ 14
HC BCKGRD METER/RANGE/PPM	5.2/ 2/ 10	4.2/ 2/ 8	4.2/ 2/ 8	3.0/ 2/ 6
CO SAMPLE METER/RANGE/PPM	17.1/13/ 15	2.7/13/ 2	6.5/13/ 6	5.0/13/ 4
CO BCKGRD METER/RANGE/PPM	.1/13/ 0	.2/13/ 0	.1/13/ 0	.3/13/ 0
CO2 SAMPLE METER/RANGE/PCT	45.9/ 3/ .79	30.8/ 3/ .51	41.7/ 3/ .71	57.4/ 3/ 1.02
CO2 BCKGRD METER/RANGE/PCT	3.0/ 3/ .05	2.9/ 3/ .04	2.7/ 3/ .04	3.1/ 3/ .05
NOX SAMPLE METER/RANGE/PPM	20.1/ 2/ 20	14.8/ 2/ 15	20.4/ 2/ 20	32.1/ 2/ 32
NOX BCKGRD METER/RANGE/PPM	1.7/ 2/ 2	1.1/ 2/ 1	1.4/ 2/ 1	1.8/ 2/ 2
DILUTION FACTOR	16.92	26.19	18.84	13.10
HC CONCENTRATION PPM	9	7	6	9
CO CONCENTRATION PPM	15	2	5	4
CO2 CONCENTRATION PCT	.75	.47	.67	.98
NOX CONCENTRATION PPM	18.5	13.7	19.1	30.4
HC MASS GRAMS	.71	.93	.51	1.03
CO MASS GRAMS	2.34	.58	.86	.95
CO2 MASS GRAMS	1884.5	2021.6	1682.2	3704.9
NOX MASS GRAMS	5.00	6.36	5.12	12.34
HC GRAMS/KM (GRAMS/MILE)	.12 (.20)	.15 (.24)	.09 (.14)	.06 (.10)
CO GRAMS/KM (GRAMS/MILE)	.40 (.65)	.09 (.15)	.15 (.24)	.06 (.09)
CO2 GRAMS/KM (GRAMS/MILE)	326.1 (524.7)	326.0 (524.5)	291.3 (468.7)	226.6 (364.5)
NOX GRAMS/KM (GRAMS/MILE)	.87 (1.39)	1.03 (1.65)	.89 (1.43)	.75 (1.21)
FUEL CONSUMPTION BY CB L/100KM(MPG)	12.17 (19.33)	12.15 (19.37)	10.85 (21.67)	8.44 (27.88)
CALCULATED DISTANCE KM (MILES)	5.78 (3.59)	6.20 (3.85)	5.78 (3.59)	16.35 (10.16)

COMPOSITE FTP RESULTS

		*CORRECTED COMPOSITE FTP RESULTS	
HC GRAMS/KM (GRAMS/MILE)	.13 (.20)	.13	(.21)
CO GRAMS/KM (GRAMS/MILE)	.17 (.28)	.18	(.29)
CO2 GRAMS/KM (GRAMS/MILE)	316.46 (509.19)	324.33	(521.94)
NOX GRAMS/KM (GRAMS/MILE)	.95 (1.54)	.97	(1.56)
FUEL CONSUMPTION BY CB L/100KM (MPG)	10.28 (22.88)	10.54	(22.19)
COMBINED FUEL ECONOMY L/100KM (MPG)	9.45 (24.89)	9.63	(24.44)

*RESULTS ADJUSTED TO INCLUDE SAMPLE PROBE FLOW RATES

TABLE B-3. VEHICLE EMISSION RESULTS
FTP

PROJECT NO. 11-4311-003

VEHICLE NO. 1
VEHICLE MODEL 79 BLUE OLDS NO.1
ENGINE 8.0 L(488 CID) V-8
TRANSMISSION A3
GVW 0 KG(0 LBS)

TEST NO. 11 RUN 1
DATE 7/12/79
TIME 10:30
DYNO NO. 2
CVS NO. 1
BAG CART NO. 1

TEST WEIGHT 1818 KG(4000 LBS)
ACTUAL ROAD LOAD 9.1 KW(12.2 HP)
DIESEL EM-321F
ODOMETER 2505

BAROMETER 739.65 MM HG(29.12 IN HG)
DRY BULB TEMP. 22.8 DEG C(73.0 DEG F)

RELATIVE HUMIDITY 69 PCT
ABSOLUTE HUMIDITY 12.4 GM/KG(86.6 GRAINS/LB)

NOX HUMIDITY C.F. 1.0576

BAG RESULTS	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	HFET
BAG NUMBER				
DESCRIPTION				
BLOWER DIF P MM. H20(IN. H20)	508.0 (20.0)	508.0 (20.0)	508.0 (20.0)	508.0 (20.0)
BLOWER INLET P MM. H20(IN. H20)	431.8 (17.0)	431.8 (17.0)	431.8 (17.0)	431.8 (17.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	33.9 (93.0)	38.3 (101.0)	36.7 (98.0)	46.1 (115.0)
BLOWER REVOLUTTONS	9336	16074	9334	14364
CVS FLOW STD. CU. METRES(SCF)	140.2 (4952.7)	238.9 (8438.4)	139.3 (4919.5)	209.4 (7394.6)
HC SAMPLE METER/RANGE/PPM	9.7/12/ 19	4.6/12/ 9	6.2/12/ 12	6.4/12/ 13
HC BCKGRD METER/RANGE/PPM	5.7/ 2/ 11	4.9/ 2/ 10	4.8/ 2/ 10	4.5/ 2/ 9
CO SAMPLE METER/RANGE/PPM	18.5/13/ 16	4.1/13/ 4	7.9/13/ 7	6.5/13/ 6
CO BCKGRD METER/RANGE/PPM	.6/13/ 1	.1/13/ 0	.1/13/ 0	.1/13/ 0
CO2 SAMPLE METER/RANGE/PCT	45.2/ 3/ .78	31.1/ 3/ .52	40.1/ 3/ .68	51.9/ 3/ .90
CO2 BCKGRD METER/RANGE/PCT	2.9/ 3/ .04	3.0/ 3/ .05	2.8/ 3/ .04	2.9/ 3/ .04
NOX SAMPLE METER/RANGE/PPM	21.7/ 2/ 22	17.5/ 2/ 18	22.2/ 2/ 22	30.5/ 2/ 30
NOX BCKGRD METER/RANGE/PPM	2.2/ 2/ 2	2.4/ 2/ 2	2.2/ 2/ 2	1.9/ 2/ 2
DILUTION FACTOR	17.20	25.94	19.66	14.80
HC CONCENTRATION PPM	9	-0	3	4
CO CONCENTRATION PPM	15	3	7	5
CO2 CONCENTRATION PCT	.73	.47	.64	.86
NOX CONCENTRATION PPM	19.6	15.2	20.1	28.7
HC MASS GRAMS	.71	-.02	.27	.52
CO MASS GRAMS	2.50	.94	1.07	1.31
CO2 MASS GRAMS	1883.8	2061.5	1629.8	3306.9
NOX MASS GRAMS	5.57	7.34	5.67	12.17
HC GRAMS/KM (GRAMS/MILE)	.12 (.20)	-.00 (-.01)	.05 (.08)	.03 (.05)
CO GRAMS/KM (GRAMS/MILE)	.44 (.70)	.15 (.25)	.19 (.30)	.08 (.13)
CO2 GRAMS/KM (GRAMS/MILE)	327.8 (527.4)	335.2 (539.4)	284.4 (457.6)	202.8 (326.4)
NOX GRAMS/KM (GRAMS/MILE)	.97 (1.56)	1.19 (1.92)	.99 (1.59)	.75 (1.20)
FUEL CONSUMPTION BY CB L/100KM(MPG)	12.23 (19.23)	12.48 (18.85)	10.60 (22.20)	7.55 (31.14)
CALCULATED DISTANCE KM (MILES)	5.75 (3.57)	6.15 (3.82)	5.73 (3.56)	16.30 (10.13)

*CORRECTED COMPOSITE FTP RESULTS

COMPOSITE FTP RESULTS			
HC GRAMS/KM (GRAMS/MILE)	.04 (.06)	0.04	(0.06)
CO GRAMS/KM (GRAMS/MILE)	.22 (.35)	0.23	(0.36)
CO2 GRAMS/KM (GRAMS/MILE)	319.71 (514.41)	327.70	(527.26)
NOX GRAMS/KM (GRAMS/MILE)	1.09 (1.76)	1.12	(1.80)
FUEL CONSUMPTION BY CB L/100KM (MPG)	10.38 (22.67)	10.64	(22.10)
COMBINED FUEL ECONOMY L/100KM (MPG)	9.11 (25.83)	9.41	(25.00)

*RESULTS ADJUSTED TO INCLUDE SAMPLE PROBE FLOW RATES

TABLE B-4. VEHICLE EMISSION RESULTS
FTP

PROJECT NO. 11-4311-003

VEHICLE NO. 1
VEHICLE MODEL 79 BLUE OLDS NO.1
ENGINE 0.0 L(-0 CID) V-8
TRANSMISSION A3
GVW 0 KG(-0 LBS)

TEST NO. 12 RUN 1
DATE 7/13/79
TIME 09:36
DYNO NO. 2
CVS NO. 1
BAG CART NO. 1

TEST WEIGHT 1818 KG(4000 LBS)
ACTUAL ROAD LOAD 9.1 KW(12.2 HP)
DIESEL EM-321-F
ODOMETER 2527

BAROMETER 740.16 MM HG(29.14 IN HG)
DRY BULB TEMP. 24.4 DEG C(76.0 DEG F)

RELATIVE HUMIDITY 63 PCT
ABSOLUTE HUMIDITY 12.4 GM/KG(86.6 GRAINS/LB)

NOX HUMIDITY C.F. 1.0578

BAG RESULTS

	1	2	3	
BAG NUMBER				
DESCRIPTION	COLD TRANSIENT	STABILIZED	HOT TRANSIENT	HFET
BLOWER DIF P MM. H2O(IN. H2O)	508.0 (20.0)	508.0 (20.0)	508.0 (20.0)	508.0 (20.0)
BLOWER INLET P MM. H2O(IN. H2O)	431.8 (17.0)	431.8 (17.0)	431.8 (17.0)	431.8 (17.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	40.6 (105.0)	40.0 (104.0)	40.6 (105.0)	47.8 (118.0)
BLOWER REVOLUTIONS	9331	16057	9338	14205
CVS FLOW STD. CU. METRES(SCF)	138.0 (4873.9)	237.8 (8399.8)	138.1 (4877.5)	206.0 (7277.6)
HC SAMPLE METER/RANGE/PPM	15.9/12/ 32	12.2/12/ 24	10.3/12/ 21	11.7/12/ 23
HC BCKGRD METER/RANGE/PPM	5.3/ 2/ 11	4.8/ 2/ 10	5.0/ 2/ 10	4.8/ 2/ 10
CO SAMPLE METER/RANGE/PPM	46.7/13/ 44	29.8/13/ 27	37.3/13/ 34	46.8/13/ 44
CO BCKGRD METER/RANGE/PPM	.6/13/ 1	.5/13/ 0	.2/13/ 0	.2/13/ 0
CO2 SAMPLE METER/RANGE/PCT	46.6/ 3/ .80	31.8/ 3/ .53	42.2/ 3/ .72	55.5/ 3/ .97
CO2 BCKGRD METER/RANGE/PCT	3.2/ 3/ .05	3.6/ 3/ .06	3.7/ 3/ .06	3.6/ 3/ .06
NOX SAMPLE METER/RANGE/PPM	20.3/ 2/ 20	15.4/ 2/ 15	20.7/ 2/ 21	30.2/ 2/ 30
NOX BCKGRD METER/RANGE/PPM	2.0/ 2/ 2	1.4/ 2/ 1	1.2/ 2/ 1	1.0/ 2/ 1
DILUTION FACTOR	16.56	25.14	18.60	13.66
HC CONCENTRATION PPM	22	15	11	19
CO CONCENTRATION PPM	42	26	33	42
CO2 CONCENTRATION PCT	.76	.47	.67	.92
NOX CONCENTRATION PPM	18.4	14.1	14.6	24.3
HC MASS GRAMS	1.74	2.09	.89	1.72
CO MASS GRAMS	6.70	7.12	5.29	10.06
CO2 MASS GRAMS	1910.3	2068.2	1682.1	3482.7
NOX MASS GRAMS	5.14	6.76	5.47	12.21
HC GRAMS/KM (GRAMS/MILE)	.30 (.48)	.34 (.54)	.15 (.25)	.10 (.17)
CO GRAMS/KM (GRAMS/MILE)	1.16 (1.87)	1.14 (1.84)	.92 (1.48)	.61 (.99)
CO2 GRAMS/KM (GRAMS/MILE)	331.3 (533.0)	332.3 (534.6)	292.6 (470.7)	212.8 (342.4)
NOX GRAMS/KM (GRAMS/MILE)	.89 (1.44)	1.09 (1.75)	.95 (1.53)	.75 (1.20)
FUEL CONSUMPTION BY CB L/100KM(MPG)	12.42 (18.93)	12.47 (18.87)	10.95 (21.48)	7.96 (29.54)
CALCULATED DISTANCE KM (MILES)	5.77 (3.58)	6.22 (3.87)	5.75 (3.57)	16.37 (10.17)

COMPOSITE FTP RESULTS

HC GRAMS/KM (GRAMS/MILE)	.28 (.45)
CO GRAMS/KM (GRAMS/MILE)	1.09 (1.75)
CO2 GRAMS/KM (GRAMS/MILE)	321.18 (516.78)
NOX GRAMS/KM (GRAMS/MILE)	1.01 (1.62)
FUEL CONSUMPTION BY CB L/100KM (MPG)	10.50 (22.41)

COMBINED FUEL ECONOMY L/100KM (MPG) 9.36 (25.14)

TABLE B-5. VEHICLE EMISSION RESULTS
FTPC + HFET

PROJECT NO. 11-4311-003

VEHICLE NO. 1
VEHICLE MODEL 79 BLUE OLDS 88
ENGINE 5.7 L(350 CID) V-8
TRANSMISSION A3
GVW 0 KG(-0 LBS)

TEST NO. 13 RUN 1
DATE 7/17/79
TIME
DYNO NO. 2
CVS NO. 1
BAG CART NO. 1

TEST WEIGHT 1818 KG(4000 LBS)
ACTUAL ROAD LOAD 9.1 KW(12.2 HP)
DIESEL
ODOMETER 2660

BAROMETER 743.20 MM HG(29.26 IN HG)
DRY BULB TEMP. 26.1 DEG C(79.0 DEG F)

RELATIVE HUMIDITY 64 PCT
ABSOLUTE HUMIDITY 13.9 GM/KG(97.4 GRAINS/LB)

NOX HUMIDITY C.F. 1.1176

BAG RESULTS

	1	2	3	
BAG NUMBER				
DESCRIPTION	COLD TRANSIENT	STABILIZED	HOT TRANSIENT	HFET
BLOWER DIF P MM. H2O(IN. H2O)	508.0 (20.0)	508.0 (20.0)	508.0 (20.0)	508.0 (20.0)
BLOWER INLET P MM. H2O(IN. H2O)	419.1 (16.5)	419.1 (16.5)	419.1 (16.5)	419.1 (16.5)
BLOWER INLET TEMP. DEG. C(DEG. F)	42.2 (108.0)	39.4 (103.0)	40.6 (105.0)	46.1 (115.0)
BLOWER REVOLUTIONS	9397	15964	9330	19178
CVS FLOW STD. CU. METRES(SCF)	139.3 (4918.7)	238.1 (8408.8)	138.8 (4901.7)	207.8 (7338.7)
HC SAMPLE METER/RANGE/PPM	11.7/12/ 23	10.5/12/ 21	5.7/12/ 11	6.2/12/ 12
HC BCKGRD METER/RANGE/PPM	5.3/ 2/ 11	4.1/ 2/ 8	4.2/ 2/ 8	4.7/ 2/ 9
CO SAMPLE METER/RANGE/PPM	27.1/13/ 24	18.6/13/ 16	19.8/13/ 18	16.2/13/ 14
CO BCKGRD METER/RANGE/PPM	.3/13/ 0	.2/13/ 0	.3/13/ 0	.2/13/ 0
CO2 SAMPLE METER/RANGE/PCT	45.6/ 3/ .78	30.4/ 3/ .50	42.1/ 3/ .72	56.5/ 3/ .99
CO2 BCKGRD METER/RANGE/PCT	3.1/ 3/ .05	3.1/ 3/ .05	2.5/ 3/ .04	3.1/ 3/ .05
NOX SAMPLE METER/RANGE/PPM	20.4/ 2/ 20	16.4/ 2/ 16	22.0/ 2/ 22	31.5/ 2/ 31
NOX BCKGRD METER/RANGE/PPM	.8/ 2/ 1	1.4/ 2/ 2	1.7/ 2/ 2	.9/ 2/ 1
DILUTION FACTOR	17.01	26.46	18.62	13.45
HC CONCENTRATION PPM	13	13	4	4
CO CONCENTRATION PPM	23	16	17	14
CO2 CONCENTRATION PCT	.74	.46	.68	.95
NOX CONCENTRATION PPM	19.6	14.6	20.4	30.7
HC MASS GRAMS	1.08	1.80	.28	.44
CO MASS GRAMS	3.77	4.39	2.71	3.29
CO2 MASS GRAMS	1882.9	1993.1	1730.2	3614.2
NOX MASS GRAMS	5.85	7.42	6.05	13.62
HC GRAMS/KM (GRAMS/MILE)	.19 (.30)	.29 (.47)	.05 (.08)	.03 (.04)
CO GRAMS/KM (GRAMS/MILE)	.66 (1.06)	.72 (1.15)	.48 (.77)	.20 (.33)
CO2 GRAMS/KM (GRAMS/MILE)	329.8 (530.7)	324.7 (522.5)	304.7 (490.2)	222.8 (358.5)
NOX GRAMS/KM (GRAMS/MILE)	1.02 (1.65)	1.21 (1.94)	1.07 (1.71)	.84 (1.35)
FUEL CONSUMPTION BY CB L/100KM(MPG)	12.33 (19.08)	12.15 (19.35)	11.37 (20.70)	8.30 (28.33)
CALCULATED DISTANCE KM (MILES)	5.71 (3.55)	6.14 (3.81)	5.68 (3.53)	14.22 (10.08)

COMPOSITE FTP RESULTS

		*CORRECTED COMPOSITE FTP RESULTS	
HC GRAMS/KM (GRAMS/MILE)	.20 (.33)	.21	(.34)
CO GRAMS/KM (GRAMS/MILE)	.64 (1.03)	.66	(1.06)
CO2 GRAMS/KM (GRAMS/MILE)	320.28 (515.33)	329.83	(530.79)
NOX GRAMS/KM (GRAMS/MILE)	1.13 (1.82)	1.16	(1.87)
FUEL CONSUMPTION BY CB L/100KM (MPG)	10.44 (22.54)	10.75	(21.86)
COMBINED FUEL ECONOMY L/100KM (MPG)	9.48 (24.82)	9.66	(24.36)

*RESULTS ADJUSTED TO INCLUDE SAMPLE PROBE FLOW RATES

TABLE B-6. VEHICLE EMISSION RESULTS
FTPC-HFET

PROJECT NO. 11-4311-003

VEHICLE NO. 1
VEHICLE MODEL 79 BLUE OLDS 88
ENGINE 5.7 L(350 CID) V-8
TRANSMISSION A3
GVW 0 KG(-0 LBS)

TEST NO. 14 RUN 1
DATE 7/18/79
TIME
DYNO NO. 2
CVS NO. 1
BAG CART NO. 1

TEST WEIGHT 1818 KG(4000 LBS)
ACTUAL ROAD LOAD 9.1 KW(12.2 HP)
DIESEL EM-321-F
ODOMETER -0

BAROMETER 739.65 MM HG(29.12 IN HG)
DRY BULB TEMP. 22.8 DEG C(73.0 DEG F)

RELATIVE HUMIDITY 73 PCT
ABSOLUTE HUMIDITY 13.1 GM/KG(91.8 GRAINS/LB)

NOX HUMIDITY C.F. 1.0858

BAG RESULTS

	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	HFET
BAG NUMBER				
DESCRIPTION				
BLOWER DIF P MM. H2O(IN. H2O)	508.0 (20.0)	508.0 (20.0)	508.0 (20.0)	508.0 (20.0)
BLOWER INLET P MM. H2O(IN. H2O)	419.1 (16.5)	419.1 (16.5)	419.1 (16.5)	419.1 (16.5)
BLOWER INLET TEMP. DEG. C(DEG. F)	41.1 (106.0)	37.8 (100.0)	41.1 (106.0)	40.6 (105.0)
BLOWER REVOLUTIONS	9372	16051	9338	14139
CVS FLOW STD. CU. METRES(SCF)	138.5 (4892.9)	239.2 (8449.7)	138.0 (4873.5)	209.2 (7389.4)
HC SAMPLE METER/RANGE/PPM	11.2/12/ 22	7.1/12/ 14	8.4/12/ 17	6.7/12/ 13
HC BCKGRD METER/RANGE/PPM	4.9/ 2/ 10	3.0/ 2/ 6	2.5/ 2/ 5	2.2/ 2/ 4
CO SAMPLE METER/RANGE/PPM	30.3/13/ 27	19.3/13/ 17	22.3/13/ 20	22.8/13/ 20
CO BCKGRD METER/RANGE/PPM	2.5/13/ 2	1.2/13/ 1	2.0/13/ 2	1.1/13/ 1
CO2 SAMPLE METER/RANGE/PCT	46.9/ 3/ .81	31.7/ 3/ .53	41.1/ 3/ .70	57.0/ 3/ 1.00
CO2 BCKGRD METER/RANGE/PCT	3.1/ 3/ .05	2.7/ 3/ .04	2.7/ 3/ .04	3.1/ 3/ .05
NOX SAMPLE METER/RANGE/PPM	23.3/ 2/ 23	17.0/ 2/ 17	20.7/ 2/ 21	31.6/ 2/ 32
NOX BCKGRD METER/RANGE/PPM	2.4/ 2/ 2	1.2/ 2/ 1	1.0/ 2/ 1	1.1/ 2/ 1
DILUTION FACTOR	16.49	25.32	19.09	13.31
HC CONCENTRATION PPM	13	9	12	9
CO CONCENTRATION PPM	24	16	18	19
CO2 CONCENTRATION PCT	.76	.49	.66	.96
NOX CONCENTRATION PPM	21.0	15.8	19.8	30.6
HC MASS GRAMS	1.06	1.17	.95	1.12
CO MASS GRAMS	3.93	4.34	2.82	4.54
CO2 MASS GRAMS	1936.0	2131.0	1665.5	3677.0
NOX MASS GRAMS	6.06	7.87	5.66	13.29
HC GRAMS/KM (GRAMS/MILE)	.18 (.29)	.19 (.30)	.17 (.27)	.07 (.11)
CO GRAMS/KM (GRAMS/MILE)	.68 (1.09)	.70 (1.12)	.49 (.79)	.28 (.45)
CO2 GRAMS/KM (GRAMS/MILE)	334.0 (537.3)	341.5 (549.5)	289.1 (465.2)	229.2 (368.8)
NOX GRAMS/KM (GRAMS/MILE)	1.04 (1.68)	1.26 (2.03)	.98 (1.58)	.81 (1.30)
FUEL CONSUMPTION BY CB L/100KM(MPG)	12.48 (18.85)	12.76 (18.43)	10.80 (21.77)	8.36 (28.12)
CALCULATED DISTANCE KM (MILES)	5.80 (3.60)	6.24 (3.88)	5.76 (3.58)	16.40 (10.19)

COMPOSITE FTP RESULTS

HC GRAMS/KM (GRAMS/MILE)	.18 (.29)
CO GRAMS/KM (GRAMS/MILE)	.64 (1.02)
CO2 GRAMS/KM (GRAMS/MILE)	325.61 (523.91)
NOX GRAMS/KM (GRAMS/MILE)	1.14 (1.84)
FUEL CONSUMPTION BY CB L/100KM (MPG)	10.61 (22.18)
COMBINED FUEL ECONOMY L/100KM (MPG)	9.60 (24.51)

TABLE B-7. VEHICLE EMISSION RESULTS
FTP

PROJECT NO. 11-4311-003

VEHICLE NO. 1
VEHICLE MODEL 79 BLUE OLDS NO.1
ENGINE 0.0 L(-0 CID) V-8
TRANSMISSION A3
GVW 0 KG(-0 LBS)

TEST NO. 11 RUN 2
DATE 7/25/79
TIME 09:38
DYNO NO. 2
CVS NO. 1
BAG CART NO. 1

TEST WEIGHT 1818 KG(4000 LBS)
ACTUAL ROAD LOAD 9.1 KW(12.2 HP)
DIESEL EM-321-F
ODOMETER 2739

BAROMETER 736.85 MM HG(29.01 IN HG)
DRY BULB TEMP. 24.4 DEG C(76.0 DEG F)

RELATIVE HUMIDITY 67 PCT
ABSOLUTE HUMIDITY 13.2 GM/KG(92.4 GRAINS/LB)

NOX HUMIDITY C.F. 1.0893

BAG RESULTS

BAG NUMBER	1	2	3	
DESCRIPTION	COLD TRANSIENT	STABILIZED	HOT TRANSIENT	HFET
BLOWER DIF P MM. H2O(IN. H2O)	495.3 (19.5)	495.3 (19.5)	495.3 (19.5)	495.3 (19.5)
BLOWER INLET P MM. H2O(IN. H2O)	406.4 (16.0)	406.4 (16.0)	406.4 (16.0)	406.4 (16.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	39.4 (103.0)	40.6 (105.0)	40.6 (105.0)	44.4 (112.0)
BLOWER REVOLUTIONS	9372	16014	9330	14174
CVS FLOW STD. CU. METRES(SCF)	138.9 (4905.8)	236.5 (8354.5)	137.8 (4867.3)	207.3 (7320.9)
HC SAMPLE METER/RANGE/PPM	9.5/12/ 19	8.4/12/ 17	5.8/12/ 12	7.4/12/ 15
HC BCKGRD METER/RANGE/PPM	4.9/ 2/ 10	4.7/ 2/ 9	5.0/ 2/ 10	4.5/ 2/ 9
CO SAMPLE METER/RANGE/PPM	23.9/13/ 21	12.1/13/ 11	13.9/13/ 12	8.9/13/ 8
CO BCKGRD METER/RANGE/PPM	1.4/13/ 1	.4/13/ 0	.3/13/ 0	.4/13/ 0
CO2 SAMPLE METER/RANGE/PCT	46.2/ 3/ .79	31.6/ 3/ .52	41.3/ 3/ .70	58.3/ 3/ 1.03
CO2 BCKGRD METER/RANGE/PCT	2.9/ 3/ .04	3.0/ 3/ .05	2.9/ 3/ .04	3.4/ 3/ .05
NOX SAMPLE METER/RANGE/PPM	20.9/ 2/ 21	16.2/ 2/ 16	21.2/ 2/ 21	31.4/ 2/ 31
NOX BCKGRD METER/RANGE/PPM	1.4/ 2/ 2	1.5/ 2/ 2	1.5/ 2/ 2	1.2/ 2/ 1
DILUTION FACTOR	16.79	25.43	19.03	12.99
HC CONCENTRATION PPM	10	8	2	6
CO CONCENTRATION PPM	19	10	12	7
CO2 CONCENTRATION PCT	.75	.98	.66	.98
NOX CONCENTRATION PPM	19.1	14.8	19.8	30.3
HC MASS GRAMS	.79	1.07	.17	.78
CO MASS GRAMS	3.15	2.75	1.86	1.73
CO2 MASS GRAMS	1914.4	2080.0	1665.5	3729.4
NOX MASS GRAMS	5.53	7.27	5.68	13.08
HC GRAMS/KM (GRAMS/MILE)	.14 (.22)	.18 (.29)	.03 (.05)	.05 (.08)
CO GRAMS/KM (GRAMS/MILE)	.55 (.88)	.46 (.75)	.32 (.52)	.11 (.17)
CO2 GRAMS/KM (GRAMS/MILE)	332.2 (534.4)	351.8 (566.1)	290.6 (467.6)	227.4 (365.9)
NOX GRAMS/KM (GRAMS/MILE)	.96 (1.54)	1.23 (1.98)	.99 (1.59)	.80 (1.29)
FUEL CONSUMPTION BY CB L/100KM(MPG)	12.40 (18.97)	13.13 (17.91)	10.83 (21.72)	8.47 (27.77)
CALCULATED DISTANCE KM (MILES)	5.76 (3.58)	5.91 (3.67)	5.73 (3.56)	16.38 (10.18)

COMPOSITE FTP RESULTS

HC GRAMS/KM (GRAMS/MILE)	.13 (.21)
CO GRAMS/KM (GRAMS/MILE)	.44 (.71)
CO2 GRAMS/KM (GRAMS/MILE)	330.48 (531.74)
NOX GRAMS/KM (GRAMS/MILE)	1.11 (1.78)
FUEL CONSUMPTION BY CB L/100KM (MPG)	10.75 (21.89)

COMBINED FUEL ECONOMY L/100KM (MPG) 9.72 (24.19)

TABLE B-8. VEHICLE EMISSION RESULTS

FET

PROJECT NO. 11-4311-003

VEHICLE NO. 1
VEHICLE MODEL 79 BLUE OLDS NO.1
ENGINE 0.0 L(-0 CID) V-8
TRANSMISSION A3
GVW 0 KG(-0 LBS)

TEST NO. 14 RUN 2
DATE 7/25/79
TIME 13:46
DYNO NO. 2
CVS NO. 1
BAG CART NO. 1

TEST WEIGHT 1818 KG(4000 LBS)
ACTUAL ROAD LOAD 9.1 KW(12.2 HP)
DIESEL EM-321-F
ODOMETER 2768

BAROMETER 736.60 MM HG(29.00 IN HG)
DRY BULB TEMP. 28.3 DEG C(83.0 DEG F)

RELATIVE HUMIDITY 56 PCT
ABSOLUTE HUMIDITY 13.9 GM/KG(97.3 GRAINS/LB)

NOX HUMIDITY C.F. 1.1171

BAG RESULTS

	HFET
BAG NUMBER	
BLOWER DIF P MM. H2O(IN. H2O)	495.3 (19.5)
BLOWER INLET P MM. H2O(IN. H2O)	406.4 (16.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	43.3 (110.0)
BLOWER REVOLUTIONS	19133
CVS FLOW STD. CU. METRES(SCF)	207.2 (7316.6)
HC SAMPLE METER/RANGE/PPM	9.4/12/ 19
HC BCKGRD METER/RANGE/PPM	5.6/ 2/ 11
CO SAMPLE METER/RANGE/PPM	29.6/13/ 22
CO BCKGRD METER/RANGE/PPM	.6/13/ 1
CO2 SAMPLE METER/RANGE/PCT	59.4/ 3/ 1.05
CO2 BCKGRD METER/RANGE/PCT	2.6/ 3/ .04
NOX SAMPLE METER/RANGE/PPM	34.0/ 2/ 34
NOX BCKGRD METER/RANGE/PPM	2.0/ 2/ 2
DILUTION FACTOR	12.70
HC CONCENTRATION PPM	8
CO CONCENTRATION PPM	21
CO2 CONCENTRATION PCT	1.01
NOX CONCENTRATION PPM	32.2
HC MASS GRAMS	1.00
CO MASS GRAMS	5.00
CO2 MASS GRAMS	3848.4
NOX MASS GRAMS	14.23
HC GRAMS/KM (GRAMS/MILE)	.06 (.10)
CO GRAMS/KM (GRAMS/MILE)	.31 (.49)
CO2 GRAMS/KM (GRAMS/MILE)	235.5 (378.9)
NOX GRAMS/KM (GRAMS/MILE)	.87 (1.40)
FUEL CONSUMPTION BY CB L/100KM(MPG)	8.78 (26.78)
CALCULATED DISTANCE KM (MILES)	16.34 (10.16)

TABLE B-9. CONVERTER INLET OXYGEN AND TEMPERATURES
UOP CATALYTIC CONVERTER

Cycle		Catalyst	Date	Temperatures °C Inlet	Outlet	Percent O_2
FTP	MAX	None	7-6-79	--	256	18.83
	MIN			--	119	7.00
HFET	MAX	None	7-6-79	--	281	18.56
	MIN			--	182	10.50
FTP	MAX	UOP-103	7-11-79	227	253	18.88
	MIN			103	103	6.88
HFET	MAX	UOP-103	7-11-79	263	276	18.76
	MIN			132	179	9.53
FTP	MAX	UOP-103	7-12-79	212	231	19.03
	MIN			100	93	7.55
HFET	MAX	UOP-103	7-12-79	230	247	18.73
	MIN			152	174	10.80
FTP	MAX	None	7-13-79	--	261	18.96
	MIN			--	127	7.50
HFET	MAX	None	7-13-79	--	278	18.51
	MIN			--	178	10.50
FTP	MAX	UOP-99	7-17-79	262	260	18.78
	MIN			126	117	7.80
HFET	MAX	UOP-99	7-17-79	281	276	18.26
	MIN			172	178	10.25
FTP	MAX	UOP-99	7-18-79	271	261	18.58
	MIN			127	107	7.25
HFET	MAX	UOP-99	7-18-79	289	278	18.51
	MIN			175	177	10.70

TABLE B-10. EXHAUST BACK PRESSURES DURING 31 KM/H CRUISE
UOP CATALYTIC CONVERTER

Catalyst	Date	Exhaust Back Pressure, kPa Right Bank
UOP-103	7-11-79	15.53
UOP-103	7-12-79	15.53
None	7-13-79	12.16
UOP-99	7-17-79	15.53
UOP-99	7-18-79	15.53

20 x 25 cm Particulate Filters

Type Test	Catalyst	Date	Filter No.	Filter Loading, mg
Cold FTP	None	7-6-79	PL-1517	295.0
Hot FTP	None	7-6-79	PL-1518	189.3
Hot FTP	None	7-6-79	PL-1519	158.4
Cold FTP	UOP-103	7-11-79	PL-1520	233.6
Hot FTP	UOP-103	7-11-79	PL-1521	159.7
Hot FTP	UOP-103	7-11-79	PL-1522	158.1
Cold FTP	UOP-103	7-12-79	PL-1523	183.6
Cold FTP	UOP-99	7-17-79	PL-1524	175.3
Hot FTP	UOP-99	7-17-79	PL-1525	157.0
Hot FTP	UOP-99	7-17-79	PL-1526	162.9